NATURAL SCIENCE

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NOTES AND COMMENTS

"Science falsely So-called"

Not infrequently we receive pamphlets that we ascribe without much hesitation to some hard-worked curate or member of a college essay society, and consign to our rubbish-box with the thought that the young man will grow wiser some day, and 'twould be shame to harm him. Of His Grace the Duke of Argyll we cannot be quit so easily: his pen has a commercial value, and what it writes does not meet with speedy oblivion. For the Duke's latest essay—a lecture entitled, "What is Science?" delivered at the opening of the Literary Society of Inverary, December 23rd, and now published by Mr David Douglas of Edinburgh—we predict a large sale. There is some sound sense in it, with useful warnings against the fallacies that may be involved in a loose use of words, and against travesties of scientific conceptions; but so far as its treatment of actual scientific conceptions is concerned, it is little advanced beyond the usual college essay. We have all of us written plenty of this kind of thing, and we have all of us wondered why scientific workers were so contemptuous of it—pig-headed, short-sighted pedants that they were! Now we ourselves are of the practical pigheads; we are doing definite work in science, and our college essays are thrown aside with the poetry that we have also all written in our springtime.. But the Duke of Argyll—should we not honour him for it?—retains all the rashness and verdure of youth, and, despite his own solemn warning, still serves up travesties of scientific conceptions and beliefs that we had thought outworn.

After the 'flower in the crannied wall' has been dragged forth for the usual purpose, we find some curious remarks on Linnaeus, who, we are told, "invented what is called the Binomial system of classification for the organic world. . . . This system . . . has been found to be so truly representative of the facts of Nature that it has been universally adopted by scientific men all over the world."

Here is a strange confusion between classification and nomenclature, between the conception and the mode of expression. This confusion is not due to scientific men, for there can scarcely be a working zoologist or botanist who has not protested that the binominal system does not represent the facts of nature; nor is the system universally accepted. How far the Duke is from apprehending this is shown by the still more startling remarks on pp. 36, 37. The following is given as a certain, undoubted, indisputable fact: "All the fresh forms of life in the past were specifically constant—just in the same way, and to the same degree, as existing forms are specifically constant now. There was no mixture. Each new pattern of creature kept its shape and pattern till it vanished. Each came and went with equal suddenness. . . . Experts in the fossils of each great rock-formation can discriminate all the species of a contemporary and of a succeeding time from each other, with the same precision and absolute identification as we can discriminate living species from each other now." Now this statement is not merely uncertain, doubtful and disputable, but we affirm that it is absolutely untrue, and that if its illustrious author had ever spent a week in the scientific study of those Cretaceous *Terebratulae* or Liassic ammonites that he mentions with such assumption of knowledge, he would have had its untruth forced upon him. People who are not experts can discriminate species with all the precision the Duke of Argyll thinks necessary for his argument, but this is just what the expert finds impossible—or, when it is possible, then he knows that the gaps which limit species are but the expressions of his own ignorance.

We need not combat the statement that the genus *Terebratula* "appeared in some of our oldest rocks," but it is surprising to see the idea of the persistence of certain organic types brought forward as though no modification of it had been rendered necessary by the advance of knowledge during a quarter of a century. So too the peculiarly erroneous remarks about the Lias ammonites might pass as mere slips, were it not that they convey a distinctly false impression, and prejudice the mind of the audience. It is not true that ammonites appear in the Lias for the first time, but were it true, their connection with the ancestral goniatites would be none the less close. It is not true that the species of ammonites are rigidly confined to zones, and that there is no link between them, "no uncertainty as to the minutest marks of difference and of identity." This is perhaps the idea one gets from text-books and from lists of fossils, but it is not the idea of the field-geologist or the practical monographer of ammonites.

To treat this kind of thing seriously is almost as absurd as the Duke's own scarification of Mr E. Stenhouse, A.R.C.S., who, it seems,

wrote a popular and chatty article on "How plants live and work" in an esteemed contemporary devoted to such literature. That the Duke should regard this seriously as 'descriptive science' by 'an advanced Darwinian' seems to show a curious absence of the real article from the bookshelves of the Athenaeum and Inverary Castle. When we come to the real argument, we find but little. The case against Darwinism may thus be summed up: 'Natural Selection' is a shocking bad metaphor, and the first 'Living Forms' arose from something that was not a 'common Parentage.' "Clearly, then, the solution offered by the Darwinian theory is . . . worse than inadequate." Not the Duke of Argyll himself can be expected to demolish the Darwinian explanation of evolution in an hour's lecture, but even a local literary society might ask with justice for more argument and less majuscular rhetoric.

The History of Geology at Oxford

In the last number of *Science Progress* Mr Sollas gives us the first fruits of his appointment to the Geological Chair at Oxford. We hope it will be followed by many harvests from the same inspiring pen. Mr Sollas must accept it as a proof of our appreciation of his work that we should raise a small polemic with him. The object of his paper is to trace the connection of Oxford with the history of geology, but Oxford has very little to do with a good deal of it. The account of Steno the Dane, which is interesting, is followed by an amusing and freshly written notice of Plot, the queer and old-world author of the Natural Histories of Oxfordshire and Staffordshire. We do not quite see how he represents the serious science taught at Oxford at any date, nor has he any real claims to a position in the history of modern science at all. Like Kircher, he was a survivor from the Middle Ages, writing in a style which is perfectly delightful for us to read. He takes us far away from orthodox thought to the kind of scientific notions which perhaps in our day sometimes floated through the brain of Charles Lamb. He was no doubt an F.R.S. and much laughed at by his friends, but he had as much in common with the little band of real men of science who founded the Royal Society as he had with the committee which tried Galileo. If we want to see what a really thoughtful man in England had made out at this time in the shape of a geological theory, we ought to turn to Martin Lister, whose work, and especially his paper in the *Philosophical Transactions*, is a remarkable production, and is only casually referred to by Mr Sollas. Though originally a Cambridge man, he was connected with Oxford, presented much to the Ashmolean Museum, and was made an M.D. of the University in 1684. He is generally credited with having been one of the first to suggest geological maps.

We also think that Prestwich might have occupied rather a larger space in a paper devoted to the connection of Oxford with geology. It is quite true that neither Prestwich nor Green fulfilled the real functions of a professor of geology. They neither of them formed a school or stirred at Oxford the ingenuous youth who are so easily stirred into an interest in the most catholic of sciences, nor did they even set their geological museum in order; but Prestwich filled the chair of geology for a long time at Oxford, was distinctly an old master in the science, and did much to help us to understand the gravels and clays and sands that cover the broken bones of the world with such a gently contoured mantle. May we hope that when the mocos have gathered round Mr Sollas' head, there will be as numerous, as distinguished, and as hearty a band of old Oxford pupils to do him honour as the other day gathered round the Woodwardian professor of Cambridge.

LUIDIUS

A MORE serious and truly strange omission from the lecture by Professor Sollas demands a separate note. It is indeed remarkable to find no mention whatever of a man whose reputation was European, and whose fame has lasted to our own day—except, apparently, "in his own country." Need we explain that we refer to Edward Lhwyd, who succeeded Plot as keeper of the Ashmolean Museum? Honest Lhwyd, as he was often called, was a man of no common industry, and spent much of his time travelling, chiefly in Wales, to collect specimens for the museum, or to examine into the languages, histories, and customs of the United Kingdom. The merest fragment of his results was published, as the first and only volume of the "Archaeologia Britannica" (1707). In geology, Lhwyd's first work was the publication of a systematic catalogue of the fossils and minerals in the Ashmolean collection, under the title "Lithophylacii Britannici ichnographia" (1699). The University, with remarkable meanness, refused to print the small octavo, and an edition of 120 copies was issued at the expense of Sir Isaac Newton, Sir Hans Sloane, and a few other learned men. After his death a second edition, with much supplementary matter, was published by William Huddesford (1760). No salary was attached to the post of Ashmolean Cimeliarch, and the chief reward that Lhwyd obtained from the University was the degree of M.A. *honoris causa*; but in return for this he had to deliver a public lecture upon natural history, "one every year during the space of six years." Thus originated his famous "Praelectio de Stellis marinis," first published in J. H. Linck's folio of the "De Stellis marinis liber singularis" (Leipzig, 1733). In November 1708, despite the opposition of Dr Woodward, whose diluvian views as to the origin of fossils Lhwyd

had attacked, he was elected a fellow of the Royal Society; and four months later the University recognised his scientific attainments by electing him superior beadle of divinity. But he died soon after, of pleurisy supervening on asthma, on June 30, 1709, being but 49 years of age.

Lhwyd was no mere cataloguer of fossils as curiosities; he recognised their true nature. "Many fossils which from long centuries ago down to the present day have been regarded as minerals, proclaim their animal origin if examined more closely: this I specially assert of the Asteria, Encrinus, and Entrochus, which I am wont to contend are nothing other than the petrified ossicles of sea-stars." As to his drawings, we have the opinion of an expert in Mr A. C. Seward's recently issued volume on "Fossil Plants":— "The oldest figures of fossil plants from English rocks which are drawn with any degree of accuracy are those of Coal-Measure ferns and other plants in an important work of Edward Lhwyd." For all this, Lhwyd did not arrive at true geological conceptions; he argued to excellent purpose against the diluvial origin of fossils, but in a letter to John Ray he suggested that they might have developed from germs brought up by vapours arising from the sea. At the same time, he insisted on the tentative nature of the suggestion, saying, "For hypotheses I have cared the less, as I have always loved natural history the more." He was, in short, an insatiable collector of facts, and capable of using his wide knowledge acutely in destructive criticism of contemporary hypotheses; but he knew too much to think that he could himself put forward a satisfactory explanation.

The Cause of Sunstroke

The current physiological theory of the existence in the body of a heat-regulating nervous centre is often supported by reference to the phenomena of sunstroke. The theory accordingly suffers by a remarkable paper on the etiology of sunstroke in a recent number of the *British Medical Journal*, in which Dr Luigi Sambon practically destroys all faith in the physical cause of that malady. Dr Sambon points out that two different conditions are often classed together as "sunstroke," and that these must be clearly distinguished before any progress can be made in understanding the genuine sunstroke. Thus he holds that many reported cases are only due to syncope. When these and other analogous cases are eliminated there remains a thermic fever, which Dr Sambon attributes to a specific organism, and for which he adopts the older name of "siriasis." This theory is startling, but Dr Sambon adduces convincing evidence in its support. He shows that it is a disease with definite symptoms and a definite geographical distribution. That it is not due to the excessive

heat he shows, and quotes cases in which people work exposed to the hottest sun, or under artificial conditions in temperatures far higher than that of any climate in the world, but nevertheless never suffer from the disease. Animals have been subjected to heat so intense as to cause their death, but they have not shown the symptoms of siriasis. The geographical distribution of the disease gives very strong support to Dr Sambon's theory. For true sunstroke is quite absent from many areas where the sun's heat is exceptionally powerful, as on the dry plains of Colorado, while it is prevalent in low, damp regions, such as the Mississippi valley, where the actual temperature is lower. In India again, it is common on the low-lying plains of the Ganges, but is unknown on the higher central plateau where the sun's power is much greater. Another argument in favour of the organic origin of the malady is the fact that it comes in epidemics, which often decimate hospital wards, where the patients are protected from the sun, and are less fatal among men working exposed to the full fury of the sun. Dr Sambon compares the bacterium to that of tetanus, for he considers that it lives in the soil, and is carried with dust either into the lungs or alimentary canal, where it forms a toxic poison which is the actual instrument of death. Dr Sambon's suggestive paper shows how little is yet known regarding some of the most fatal of tropical diseases, the further study of which is a duty on the part of the nation, which is responsible for the administration of so large a proportion of the tropical regions.

The Effect of Aquatic Plants on Water Supplies

Now that the legislature throws upon our urban and district councils the onus of providing 'pure' water, the study of everything affecting either the purity or palatability of water has assumed great practical importance. As a broad fact it is doubtless true that the growth of green plants in water causes the water to be oxygenated and makes for purity. It has been known for some time that the growth of certain low forms of vegetable life in water is capable of imparting to it a disagreeable odour owing to the impregnation of the water by bodies resembling essential oils. Thus it is recorded by Dr Thresh, that in 1891 the water of Bolton in Lancashire acquired a 'fishy' odour and taste owing to the growth of a certain fresh-water alga, and a similar accident happened at Cheltenham in the same year.

The latest addition to our knowledge on this subject comes from Massachusetts in a paper by Messrs Jackson and Ellms, who are respectively assistant biologist and assistant chemist to the State Board of Health.

In 1895 an abundant growth of *Anabaena*, one of the Cyano-

phyceae, took place on a reservoir at Springfield, Mass. The growth imparted to the water an odour of mouldy grass, and by extracting a large quantity with gasolene, the authors of the paper succeeded in obtaining an essential oil having the characteristic smell of 'mouldy grass.'

It is evident that any vegetation taking place in water may die and undergo a process of rotting and putrefaction, and it must be clearly understood that *Anabaena* and other organisms impart their odour during growth and not after death. When the *Anabaena* dies and decays it imparts to the water the odour of a pig-stye, or, as the authors of the paper put it, "the odor of a pig-pen."

The mutual relation between aquatic plants and the medium in which they grow is a question well worthy careful study, and is calculated to throw some light on the seasonal variations in the quality of water from the same source, which are often a puzzle to the analyst and not without interest to the epidemiologist.

The North Sea Fisheries

The Northumberland Sea Fisheries Committee have continued their trawling experiments, and the results obtained during the summer of 1897 are embodied in a small Report. So far as the observations extend, they appear to point to the conclusion "that the flat fishes during the last two years have increased to the extent of thirty per cent. compared with the four previous years." This result must be regarded as encouraging, though the experience of similar experiments elsewhere demands extreme caution in drawing conclusions.

In the account of pelagic eggs, those of the weever, dab, and gurnard are said to occur in the inshore waters in abundance, in addition to unknown eggs, 'perhaps Müller's topknot,' some of which may be *Motellae*. So long as trawling operations are commenced as late as the third week in June, the Committee must not expect to obtain the eggs of gadoids or of the commoner pleuronectids in either the inshore waters or beyond the three-mile limit. If a serious attempt at investigating the pelagic eggs of the district is to be made, systematic trawling should commence at the latest in early March.

The founding of a laboratory at Cullercoats is due, as is so often the case in our country, to the generosity of a private individual, and in this instance the donor is Mr Dent, the owner of the steamer *Livingstone*, with which the trawling experiments have been accomplished. With the College of Science in easy distance, and with many well-known local naturalists, this laboratory should have a bright career before it.

Plankton Crustacea of Lake Mendota

For two years and a half, namely, from the middle of 1894 to the end of 1896, Prof. E. A. Birge, of the University of Wisconsin.

carried out the very praiseworthy but arduous work of systematically watching the Crustacea of the plankton of Lake Mendota. The results, which have now been published in the *Transactions* of the Wisconsin Academy of Sciences, etc. (Vol. xi. pp. 274-448), form extremely instructive reading to those who, like ourselves, are interested in the progress of fresh-water biology.

Briefly, the method adopted in the work was as follows: Vertical hauls were made with a plankton net, at very frequent intervals, at a spot about half a mile from the southern shore of the lake. A separate haul was made for every three metres of the total depth (18 m.), the mouth of the net being closed at the proper moment by a messenger sent down the line. The Crustacea contained in a definite fraction of each collection were then counted and the figures so obtained formed the basis of all the subsequent calculations as to the periodicity, vertical distribution, etc., of the different species.

It appears that Lake Mendota has altogether eleven or twelve species of limnetic crustacea (Entomostraca). Of these, only eight are of real importance as constituents of the plankton. As regards the seasonal distribution of the Crustacea as a whole, Prof. Birge finds that there are, during the course of each year, three maximum periods of development, occurring in May, July, and September-October respectively. During the spring maximum, which is the greatest, and is produced almost entirely by the marvellous increase of a single species of *Cyclops*, as many as 3,000,000 individuals may be present under each square metre of the surface of the lake. As regards the occurrence of the individual species a very valuable collection of facts has been obtained, but it is impossible to refer to these in detail. It may be specially mentioned, however, that in one case, *Daphnia pulicaria*, the evidence seems to show that biennial periodicity may occur among plankton organisms as well as annual.

The vexed question of the uniformity or otherwise of the horizontal distribution of the plankton is answered by Prof. Birge as follows: "In general, there is no evidence of swarms in my observations, either of all the Crustacea or of single species," but "the variation of the numbers of the Crustacea in Lake Mendota does not support extreme views either on the side of uniformity of distribution or the opposing theory of swarms."

The "Sprungschicht" or Thermocline

One of the most characteristic features of the work carried out on Lake Mendota is the attention which has been paid to what is known to German authors as the "Sprungschicht," or, as Prof. Birge calls it, the Thermocline. It was first announced by E.

Richter in 1891 that there existed in many lakes, during the summer, a layer of water in which an extremely rapid decrease in temperature took place. For instance, the difference in the temperature of the water of a lake from the surface down to perhaps ten metres might only be one or two degrees, whereas in the next metre or two the decrease might amount to ten degrees or more. Below this, again, the temperature would decrease comparatively slowly and uniformly to the bottom. The layer showing the great jump in temperature was christened the "Sprungschicht," and its position was found to vary with the season, gradually sinking as the year advanced.

References to the "Sprungschicht" or Thermocline have been made by many subsequent writers, but Prof. Birge seems to be one of the first to have shown how important the phenomenon may be to the plankton organisms in certain cases. In Lake Mendota, for example, he finds that the formation of the Thermocline is followed by the practical stagnation of the whole mass of the water lying below, and as the latter is obviously shut off from direct exposure to sun and air it soon becomes unfit to support the majority of the inhabitants of the lake. In less than a month, therefore, after the appearance of the Thermocline, *i.e.* before the middle of July, from 90 to 95 per cent. of all the Crustacea present in the lake are found above the 9-metre level, which represents approximately the middle of the Thermocline at that date. This state of things continues during July, August, and part of September, except that, as the Thermocline moves gradually downwards, the Crustacea have more room in which to develop, and so, by the middle of September, the high percentages mentioned can only be obtained by collecting to a depth of about 12 metres. Two of the effects of this practical exclusion of life from the lower water during the summer are, that the total number of Crustacea in the lake is far smaller than it would otherwise be, and that the perennial species which are unfavourably affected by heat, being unable to retire into the cooler water, decline in numbers. Perhaps also the small number of periodic species in the lake may be due to the fact that they have little chance to develop when the habitable water above the Thermocline is so completely occupied by the perennial forms.

The Thermocline is closely connected with another peculiarity of Lake Mendota, and that is the enormous increase of the vegetable plankton in the late summer and autumn, for it appears certain that this is rendered possible by the liberation of the products of decomposition stored in the deeper water, as the Thermocline moves downwards.

As regards the production of the Thermocline, Prof. Birge believes that, in Lake Mendota at least, it is due to the concurrence of gentle winds and hot weather, and not to the day and night differences in temperature of the surface water, as is stated by Richter and others.

The Mollusca of Lake Tanganyika

Since his return from Africa, Mr J. E. S. Moore has been hard at work examining the animals, especially the mollusca, brought back by him from Lake Tanganyika. It has already been announced that the fauna of this lake furnishes evidence for its connection with the sea at no very distant date, geologically speaking. On January 27th Mr Moore read before the Royal Society a paper on this subject, of which the following extract has been issued:—

"The results of the morphological examination of the animals obtained have made it evident that the fauna of Lake Tanganyika must be regarded as a double series, each half of which is entirely distinct in origin and nature from the other. The remarkable molluscan shells which were brought home by Burton and Speke, form but a small part of the molluscan section of the more abnormal of these fresh-water stocks. Besides molluscs, the lake was found to contain fishes, Crustacea, Coelenterata, and Protozoa, all of which, like Speke's shells, present the most curious marine affinities; and for distinctive purposes the individual members of this unique assemblage of quasi-marine fresh-water organisms are described as members of the Halolimnic group.

"The distribution of the aquatic faunas occurring in Lakes Shirwa, Nyanza, Kela, and Tanganyika, all of which were visited and dredged during the expedition, shows (together with what is already known respecting the Victoria Nyanza and the more northern lakes) that the Halolimnic animals are exclusively restricted to Tanganyika. It is thus rendered inconceivable that the Halolimnic forms can have arisen through the effect of ordinary conditions operating upon the population which the lake originally possessed. For the same reasons, it becomes equally clear that the Halolimnic animals cannot be regarded as the survivors of an old fresh-water stock. Since, if we accept either of these suppositions, we are bound by the facts of distribution to believe also that the Halolimnic animals have been destroyed in every African lake but one; a supposition which may be ingenious, but which, when the number of lakes existing in the African interior is fully realised, becomes grotesque.

"Apart from the physical difficulties which the present effluent of Tanganyika presents to the ingress of organisms from the sea, it is impossible to regard the Halolimnic forms as having recently transmigrated thither from the ocean, since none of these animals is exactly similar to any marine organism at present known. They must, therefore, have been in Tanganyika long enough to be modified into their present condition from the living oceanic species which we know, or they retain the characters of a sea-fauna that has elsewhere become extinct.

"The delicate nature of the lake medusae, and the fact that most of the Halolimnic molluscs are exclusively deep-water forms, renders it impossible that these organisms can have made their way into Tanganyika at any time under the physical conditions which now exist.

"The facts of distribution and the general character of these forms, as well as the geographical conditions of the lake in which they are now found, lead then to the conclusion that the Tanganyika region of Central Africa must have approximated to a deep arm of the sea in ancient times.

"This view is finally confirmed by the details of the anatomy of the Halolimnic animals themselves. For some of the individual molluscs of this group combine the characters of several of the most modern marine genera. The Halolimnic fauna of Tanganyika, therefore, cannot represent an extinct fresh-water stock, since the characteristic fresh-water organisms of the present day (which would, in such a case, have to be regarded as their linear descendants) possess the anatomy of vastly older types.

"To the Halolimnic animals there thus attaches the unique interest that they themselves constitute the few surviving indications of an old sea which once extended far into the African interior, and which, judging from the characters of the animals it left behind, must have retained its connection with the ocean at least as late as Tertiary times.

"These conclusions, it will be observed, are directly in opposition to the views which were originated by Murchison, and which depict the African interior as never having been below the sea, at least since the New Red Sandstone age."

Some New Bivalves

There is evidently much work to be done amongst small bivalves. Most collectors shirk them owing probably to the difficulty they find in discriminating between young individuals of large species and genuine small forms. Mr Felix Bernard's researches into the development of the hinge in the Pelecypoda are, however, doing much to make the task easier; whilst to the fact that in the course of his studies, small shells have of late principally occupied his attention, must be due his numerous recent discoveries of minute but fully grown pelecypods. Three new genera are now founded by him (*Bull. Mus. Hist. Nat. Paris*, 1897, pp. 309-14) on specimens in material from Stewart Island, near New Zealand. One of these, *Pachykellya*, belongs to the family Erycinidae, the other two, *Cyamiomactra* and *Perrierina* are doubtfully referred to the Mactridae. The first named measures but 1 × 2 mm. and the second 4·5 × 3 mm. The third is, however, perhaps the most interesting,

seeing that its hinge, like the Tertiary genus *Woodia*, Desh., combines cardinal teeth of the heterodont type, with laterals that recall those of the Anisomyaria and even the Taxodonta.

North American Copepods of the Genus Diaptomus

The Illinois State Laboratory of Natural History has lately issued another of its very useful little Bulletins dealing with North American fresh-water Invertebrates. It treats of the genus *Diaptomus* and is essentially a systematic paper, appealing mainly to students of the Copepoda. But it also brings out a point of some general importance, namely, that not one of the twenty-two species described occurs in any part of Europe. This is a very remarkable fact when it is remembered that nearly all the North American species of the genus *Cyclops*, and more than fifty per cent. of the fresh-water Ostracoda and Cladocera are common to North America and Europe. It looks very much as if, notwithstanding a continuous process of intermingling of the majority of the Entomostraca of the two continents, the American forms of *Diaptomus* have been effectively isolated from all European influences for a sufficiently long time to allow of the development of an entirely new set of species. This, of course, implies that the Atlantic forms an impassable barrier to the latter, but that it does not seriously affect the active dispersal of the Entomostraca as a whole, and it also probably implies that the comparatively short time (geologically) which has elapsed since the breaking up of the northern land connection between America and Europe has been sufficient for the production of great difference in the *Diaptomus* faunas of the two continents which now exists.

Some Remarkable Earwigs

Among recent contributions to the life-histories of insects, none will prove more interesting than the paper by Mr E. E. Green, which was read before the Entomological Society last March. About two years previously the author had exhibited to the Society some remarkable insects from Ceylon, which he believed to be later stages in the development of the species figured and described by Westwood in 1881 under the name of *Dyscritina longisetosa*. Westwood was unable to assign a definite systematic position to his new genus, the type of which was a small insect, somewhat resembling an earwig, but provided with two long slender tail-filaments, each of which was about three times the length of the creature's own body, and made up of about fifty minute segments. Mr Green was able to shew by means of drawings that, except for the segmented tail-appendages, the insects he exhibited possessed all the characters of true earwigs, and he ventured to express an opinion, in which he was supported by Mr Gahan, that these insects represented larval stages of forms

which should be referred to the family Forficulidae. Though this view met with strong opposition at the time, it is now proved to be entirely true. Since his return to Ceylon, Mr Green has studied pretty completely the life-histories of the insects in question, and in the paper referred to has communicated the results of his investigations. He has shewn that the long-tailed larvae become transformed into ordinary-looking earwigs, each provided with the orthodox pair of pincers. The segmented tails are retained by the larvae up to the final moult preceding the change to the imago. They then disappear, with the exception of the long basal segment of each tail. The pincers of the imago may be seen formed within these basal segments, and Mr Green is of opinion that the pincers represent the basal segments only of the larval tails. Mr Gahan, however, considered it more probable that the whole interior substance of each tail was contracted within the basal segment, and there became changed into the pincer, in support of which view he mentioned the fact, noted by himself, that traces of segmentation might be observed in the pincers of the common earwig at a stage just preceding the exclusion of the embryo from the shell.

Photography in Geology

In our March number we alluded to the work being done in collecting photographs illustrative of British Geology. It is no doubt a fact that the prints receive house-room at the Museum of Practical Geology, but the actual work is one carried out by private individuals. The April number of the *Photogram* gives a very interesting account of the photographic work in connection with the U.S. Geological Survey. We have, in this country, various scientific institutions under Government, which appear to make far less use of photography than might be expected; but this is a subject to which our opportunities of returning will be perennial. At present we content ourselves with quoting some of the paragraphs from the *Photogram*.

"The official photographer of the Survey, J. K. Hilliers, who is responsible for the work of a very great number of field photographers, and also of a considerable in-door staff, is entirely a self-taught man, who originally joined one of the geological parties as a baggage packer. Assisting the photographer attached to the party, he gradually picked up the methods of working, and, when the photographer died, was able to continue his duties. From this time he always remained a photographer, gradually rising in the service, until with the increase of the service itself, he has now a very responsible position. His work shows that he is a photographic genius, as well as a good deal of an artist, as our readers will have an opportunity of proving for themselves at the Paris Exhibition of 1900. For this exhibition the Geological Survey is preparing a

magnificent collection of very large-sized photographic transparencies of American scenery, all beautifully coloured, and from what we have seen of the few that were already completed, and others in progress, when we were in Washington, we feel safe in saying that they will be amongst the most interesting and striking of the photographic exhibits at the Paris World's Fair."

"THE PHOTOGRAM" ON THE U.S. GEOLOGICAL SURVEY

"THE Geological Survey, unlike the War Department, is very well housed in a good studio and excellently fitted dark-rooms and work-rooms. Its space is none too large for the number of men who are busy therein, but they have, at any rate, every convenience they can fairly ask. Of course the bulk of their work consists of developing, printing, and generally making useful the exposed plates which are sent to them by workers in the field, and, as there are over one hundred cameras in constant use by members of the Survey, for each field party has at least one camera in its equipment, it can easily be imagined that the work is no sinecure. Perhaps we ought to explain that the Geological Survey in America occupies a much more important position, and has much more extensive duties than its name would seem to indicate, for its work includes that which, in Britain, is undertaken by the Ordnance Survey, in addition to the work of a Geological Survey proper. Even geology is understood in a very wide sense by the American Government, for the most important 'rock' with which they deal is water, and it is one of the duties of the Survey to give information to people all over the States, who may be contemplating the driving of wells or the planning of irrigation works. This being the case it can easily be understood not only that the hydrographer's department, with F. H. Newell at its head, is an important and busy section, but also that the work generally is much more extensive than the work of a similiar survey in Europe. The printing and publishing department of the Geological Survey (for it issues all the official maps of the States) is decidedly interesting, though decidedly disappointing from the point of view of the photographic and photo-mechanical enthusiast. Probably there is no Survey in the world in the map-printing establishment of which photography is so little used. This does not, in any sense, arise from any objection to photographic methods, for, as a matter of fact, the head of the printing department is most anxious to use photography wherever practicable, and has an unusually good knowledge of its possibilities and application. At the same time, the introduction of photography to any great extent would mean a revolution of the whole methods of the Survey, and would have only doubtful advantages, since the present working seems to compare very favourably, in point of both cost and

accuracy, with the methods of other countries working similar territory. One reason why it is difficult to use photography to the same proportionate extent, as is done, say, in the printing offices at Southampton, is that the American maps are all printed in a considerable number of colours. Of course, even in this case, it might be urged that the black printing could be done from photo-gravure plates, and the colour plates made on transfers therefrom, but the American surveyors seem to decidedly prefer to have their maps finished up by the workers actually in the field. The result of this is that, although the field worker's map is perfectly accurate for engraving by hand, it is not sufficiently clean and sharp in its lines for direct photo-engraving; hence, if photographic reproductions were used, it would be necessary to make a clean copy by hand in the establishment, and it is considered more accurate and more economical to make a transfer from the field map direct to the copper-plate and to engrave it by hand. The exceedingly low price at which the maps of the Survey are sold, shows that their cost of production must be reasonable, since they are supposed to be sold at cost price, and certainly their cost to the public compares very favourably with the price of the maps produced by the British Surveys."

Rust on Cereals

Professor J. Eriksson has published in the *Botanical Gazette*, vol. xxv., Jan. 1898, a short account of the results he has obtained from his researches on the rust of cereals at the experiment station of the Royal Swedish College of Agriculture.

He subdivides the three species of rust, *Puccinia graminis* Pers., *P. rubigo-vera* D.C., and *P. coronata* Corda into ten distinct species, and he finds further that forms of these have become restricted to particular hosts; the danger of infection spreading from one diseased grass to that of another genus or species is thus very much lessened. Another point of extreme interest is the difficulty he found in inducing certain teleutospores to germinate until, by laying them on ice, he imitated natural conditions of winter temperature. This explains the difficulty experienced in germinating the spores obtained from straw used as manure, and it gives the agriculturist greater confidence in using rusted straw.

After many experiments Professor Eriksson has come to the conclusion that though rust increases by infection it is largely propagated by inheritance. He supposes that "the fungus lives for a long time a latent symbiotic life as a mycoplasma in the cells of the embryo and of the resulting plant, and that only a short time before the eruption of the pustules, when outer conditions are favourable, it develops into a visible state assuming the form of a mycelium."

This is evidently a matter of theory and will be difficult to prove, but we await Professor Eriksson's further publications with great interest. The whole subject, as he himself states, is of great practical importance.

The New Academy of Sciences at Washington

The following have been elected officers of the Washington Academy of Sciences: — President, J. R. Eastman; secretary, G. K. Gilbert; treasurer, Bernard R. Green; managers—Alexander Graham Bell, Frank Baker, F. W. Clarke, C. Hart Merriam, H. S. Pritchett, George M. Sternberg, Charles D. Walcott, Lester F. Ward, and Caroll D. Wright. The seven vice-presidents will be nominated by the seven affiliated societies — Anthropological, Biological, Chemical, National Geographic, Geological, Entomological, and Philosophical. The Act of Incorporation of the Academy states that its object is the promotion of science with power:—(*a*) To acquire, hold and convey real estate and other property and to establish general and special funds; (*b*) to hold meetings; (*c*) to publish and distribute documents; (*d*) to conduct lectures; (*e*) to conduct, endow, or assist investigation in any department of science; (*f*) to acquire and maintain a library; (*g*) and, in general, to transact any business pertinent to an academy of sciences.

The South Kensington Museum

In connection with the proposed action of the Government at South Kensington Museum, the following little extract from the report of proceedings in Parliament on March 29th may interest and possibly amuse our readers:—

"Mr H. Lewis moved to reduce the amount proposed to be expended at South Kensington by £100,000, in order to draw the attention of the Government to the fact that in Wales there was no provision for museum purposes such as existed in England, Ireland. and Scotland. What he asked was that in Wales they should have a storehouse for their national art treasures.

"Mr Labouchere suggested that the Imperial Institute should be purchased and used as the new museum for science and art treasures. The Colonies had declined to subscribe to it, and as it was principally used as a species of music-hall, he thought it might be bought cheaply.

"Mr Akers-Douglas said he sympathised with the desire of the Welsh people to have a proper museum, but it was a matter that he could not enter into upon this Bill. As to the Imperial Institute, he understood that the owners were not willing to sell, and it was not the intention of the Government to ask for compulsory powers of purchase."

The Newcastle Museum

We much regret to learn that the building of the Museum at Barras Bridge, Newcastle, is in a somewhat dilapidated condition, and that it was necessary to call a special meeting of the members of the Natural History Society of the counties of Northumberland, Durham, and Newcastle, on March 16th, to consider how funds could be raised to provide the necessary repairs. The connection of this museum with Albany and John Hancock is well known, and many other naturalists of repute have carried on their work there. In consequence of this, the collections are of more value than is usual in a provincial museum, and it is certainly some consolation to find that the members of the above-mentioned Society fully realise the necessity of doing their work thoroughly while they are about it. £110 was promised by those present at the meeting. Lord Armstrong, who is President of the Society, has offered £500, and Mr Watson-Armstrong, who took the chair at the meeting, subscribed another £250. There can be little doubt that to such an example the public will respond, and that before long the £2500 necessary will be acquired. So long as the members of the Natural History Society of Northumberland, Durham, and Newcastle realise their responsibilities in this excellent fashion, so long, no doubt, will their Museum continue to be cared for, as it deserves. But it must not be forgotten that Societies are composed of men, and that men are but mortal. Those may arise in the land who know not Hancock, and who do not feel inclined to double their subscriptions, or to subscribe odd £500-notes. As has often been urged by Sir William Flower, the only way in which museums of this kind can be secured against possible disaster is to place them in the hands of some public body. We will not say that a municipal corporation is in itself more friendly to science than a private scientific society, but it has the one great advantage of permanence.

The Chadwick Museum, Bolton

A striking novelty in museum exhibits has been introduced at the Chadwick Museum of Natural History, Bolton, Lancashire, in the shape of a colony of honey bees. These are kept in an 'observatory hive,' which stands on one of the side tables overlooking the Park, with an aperture through the wall for egress and ingress. We are told in the *Report* that "to watch the movement of these industrious insects inside their house has excited the wonder and admiration of thousands of visitors." We do not suggest that a museum should usurp the functions of a zoological garden, but anything which tends to enliven these storehouses of the dead is to be commended, and we hope the example set by Bolton will be followed.

It is a move similar to that made by the Australian Museum at Sydney and the Whitechapel Museum, London, of holding temporary exhibits of cut flowers.

We notice that the Chadwick Museum is making progress in other directions. It has acquired a collection of British birds' eggs containing 229 species, and the number of birds' nests has been increased, chiefly by a loan for an indefinite period by Mr F. W. Peaples. During the past year 2500 specimens of British insects, chiefly British Coleoptera and Lepidoptera, have been acquired. A large Polar bear has been presented by Messrs Jennison; and the mammalian collection has been rearranged in a new large cabinet. Numerous visits have been made by classes from the elementary schools and by Natural History Societies from the neighbourhood. The Bolton Botanical Society holds its fortnightly meetings in the building. The whole *Report* gives evidence of praiseworthy activity. The curator, who also combines the functions of meteorological observer, is Mr W. W. Midgley.

Pigeon-holes for Zoologists

In our April number we gave some account of the present position of the International Bureau for the Bibliography of Zoology at Zurich, and we then stated the facilities that are now offered to subscribers. By arrangement with Dr Field we are able to present purchasers of the present number with the scheme of classification now adopted for a portion of the subjects dealt with by the Bibliographic Bureau, and we need only remind our readers that they can purchase, in card-catalogue form, the entries relating to any one of these headings or to any combination of these headings. For example, one can order the entries relating to 591412, the anatomy of the heart; or 59932, Rodentia; or 59(4346) zoology of Baden; or 59932 (4346), Rodents of Baden. We are told that about 100 entries are printed every day under the headings contained in this list, and this gives some idea of the flood of literature under which the isolated worker must sink if he does not use some such means as this to help him. This list need not be regarded merely as a sale-catalogue, but it may offer suggestions to workers as to a plan of arranging their own pamphlets or even manuscript notes. Many people no doubt like to make their own pigeon-holes, but others never find the time for that, and are glad to take them ready-made. As has often been pointed out, this system of division and notation permits of indefinite extension; and in this especially lies its value to the private worker.

I

Cell-Physiology

[THE revised *Principles of Biology* which I am slowly preparing is to contain additional chapters; sundry of them made needful by recent developments of biological science. One of these, entitled "Cell-Life and Cell-Multiplication," describes, so far as brevity allows, the revelations which late years have witnessed respecting the processes of cell-division and cell-fertilization. Study of the facts and hypotheses, as set forth in recent works, have suggested to me some interpretations which I have not met with. I have thought it as well to publish them now: not waiting for completion of the first volume of the *Principles of Biology*; as this will be long delayed, even if ill-health does not prevent completion of it. The following are the relevant passages.—HERBERT SPENCER.]

THE chemical composition of chromatin is highly complex, and its complexity, apart from other traits, implies relative instability. This is further implied by the special natures of its components. Various analyses have shown that it consists of an organic acid (which has been called nucleic acid) rich in phosphorus, combined with an albuminous substance: probably a combination of various proteids. And the evidence, as summarised by Wilson, seems to show that where the proportion of phosphorized acid is high the activity of the substance is great, as in the heads of spermatozoa; while, conversely, where the quantity of phosphorus is relatively small, the substance approximates in character to the cytoplasm. Now (like sulphur, present in the albuminoid base), phosphorus is an element which, besides having several allotropic forms, has a great affinity for oxygen; and an organic compound into which it enters, beyond the instability otherwise caused, has a special instability caused by its presence. The tendency to undergo change will therefore be great when the proportion of the phosphorized component is great. Hence the statement that "the chemical differences between chromatin and cytoplasm, striking and constant as they are, are differences of degree only;" and the conclusion that the activity of the chromatin is specially associated with the phosphorus.

What, now, are the implications? Molecular agitation results from decomposition of each phosphorized molecule: shocks are continually propagated around. From the chromatin, units of which are thus ever falling into stabler states, there are ever being diffused waves of molecular motion, setting up molecular changes in the cytoplasm. The chromatin stands towards the other contents of the cell in the same relation that a nerve-element stands to any element

of an organism which it excites: an interpretation congruous with the fact that the chromatin is as near to as, and indeed nearer than, a nerve-ending to any minute structure which it stimulates.[1]

Several confirmatory facts may be named. During the intervals between cell-fissions, when growth and the usual cell-activities are being carried on, the chromatin is dispersed throughout the nucleus into an irregular network: thus greatly increasing the surface of contact between its substance and the substances in which it is imbedded. As has been remarked, this wide distribution furthers metabolism—a metabolism which in this case has, as we infer, the function of generating, not special matters but special motions. Moreover, just as the wave of disturbance a nerve carries produces an effect which is determined, not by anything which is peculiar in itself, but by the peculiar nature of the organ to which it is carried —muscular, glandular or other; so here, the waves diffused from the chromatin do not determine the kinds of changes in the cytoplasm, but simply excite it: its particular activities, whether of movement, absorption, or structural excretion, being determined by its constitution. And then, further, we observe a parallelism between the metabolic changes in the two cases; for, on the one hand, "diminished staining capacity of the chromatin [implying a decreased amount of phosphorus, which gives the staining capacity] occurs during a period of intense constructive activity in the cytoplasm;" and, on the other hand, in high organisms having nervous systems, the intensity of nervous action is measured by the excretion of phosphates—by the using up of the phosphorus contained in nerve-cells.

For thus interpreting the respective functions of chromatin and cytoplasm, yet a further reason may be given. One of the earliest general steps in the evolution of the *Metazoa*, is the differentiation of parts which act from parts which make them act. The *Hydrozoa* show us this. In the hydroid stage there are no specialized contractile organs: these are but incipient: individual ectoderm cells have muscular processes. Nor is there any "special aggregation of nerve-cells." If any stimulating units exist they are scattered. But in the *Medusa*-stage nerve-matter is collected into a ring round the edge of the umbrella. That is to say, in the undeveloped form such motor action as occurs is not effected by a specialised part

[1] While the proof was in my hands there was published in *Science Progress* an essay by Dr T. G. Brodie on "The Phosphorus-containing Substances of the Cell." In this essay it is pointed out that "nucleic acid is particularly characterised by its instability. . . . In the process of purification it is extremely liable to decompose, with the result that it loses a considerable part of its phosphorus. In the second place it is most easily split up in another manner in which it loses a considerable part of its nitrogen. . . . To avoid the latter source of error he (Miescher) found that it was necessary to keep the temperature of all solutions down to 0°C. the whole time." These facts tend strongly to verify the hypothesis that the nucleus is a source of perpetual molecular disturbance—not a regulating centre but a stimulating centre.

which excites another part; but in the developed form a differentiation of the two has taken place. All higher types exhibit this differentiation. Be it muscle or gland or other operating organ, the cause of its activity lies not in itself but in a nervous agent, local or central, with which it is connected. Hence, then, there is congruity between the above interpretation and certain general truths displayed by animal organisation at large. We may infer that in a way parallel to that just indicated, cell-evolution was, under one of its aspects, a change from a stage in which the exciting substance and the substance excited were mingled with approximate uniformity, to a stage in which the exciting substance was gathered together into the nucleus and finally into the chromosomes: leaving behind the substance excited, now distinguished as cytoplasm.

Some further general aspects of the phenomena appear to be in harmony with this interpretation. Let us glance at them.

There is good reason for concluding that in the animal organism nitrogenous substances play the part of decomposing agents to the carbo-hydrates—that the molecular disturbance set up by the collapse of a proteid molecule destroys the equilibrium of sundry adjacent carbo-hydrate molecules, and causes that evolution of energy which accompanies their fall into molecules of simpler compounds. Here, if the foregoing argument is valid, we may conclude that this highly complex phosphorised compound which chromatin contains plays the same part to the adjacent nitrogenous compounds as these play to the carbo-hydrates. It may be pointed out that in animal organisms the various structures are so arranged that evolution of a small amount of energy in one, sets up evolution of a larger amount of energy in another; and often this multiplied energy undergoes a second multiplication of like kind. If this view is tenable, we may now suspect that this method displayed in the structures of the *Metazoa* was initiated in the structures of the *Protozoa*, and consequently characterises those homologues of them which compose the *Metazoa*.

When contemplated from the suggested point of view, karyokinesis appears to be not wholly incomprehensible. For if the chromatin yields the energy which initiates changes throughout the rest of the cell, we may see why there eventually arises a process for exact halving of the chromatin in a mother-cell between two daughter-cells. To make clear the reason, let us suppose the portioning out of the chromatin leaves one of the two with a sensibly smaller amount than the other. What must result? Its source of activity being relatively less, its rate of growth and its energy of action will be less. If a protozoon, the weaker progeny arising by division of it will originate an inferior stirp, unable to compete

successfully with that arising from the sister-cell endowed with a larger portion of chromatin. By continual elimination of the varieties which produce unequal halving, necessarily at a disadvantage if a moiety of their members tend continually to disappear, there will be established a variety in which the halving is exact: the character of this variety being such that all its members aid the permanent multiplication of the species. If, again, the case is that of a metazoon, there will be the same eventual result. An animal or plant, in which the chromatin is unequally divided among the cells, must have tissues of uncertain formation. Assume that an organ has, by survival of the fittest, been adjusted in the proportions and qualities of its parts to a given function. If the multiplying protoplasts, instead of taking equal portions of chromatin, have some of them smaller portions, the parts of the organ formed of these, developing less rapidly and having inferior energies, will throw the organ out of adjustment, and the individual will suffer in the struggle for life. That is to say, irregular division of the chromatin will introduce a deranging factor, and natural selection will weed out individuals in which it occurs. Of course no interpretation is thus yielded of the special process known as karyokinesis. Probably other modes of equal division might have arisen. Here the argument implies merely that the tendency of evolution is to establish some mode. In verification of the view that equal division arises from the cause named, it is pointed out to me that amitosis, which is a negation of mitosis or karyokinesis, occurs in transitory tissues or diseased tissues, or where degeneracy is going on.

But how does all this consist with the conclusion that the chromatin conveys hereditary traits—that it is the vehicle in which the constitutional structure, primarily of the species, and secondarily of recent ancestors and parents, is represented? To this question there seems to be no definite answer. We may say only that this second function is not necessarily in conflict with the first. While the unstable units of chromatin, ever undergoing changes, diffuse energy around, they may also be units which, under the conditions furnished by fertilization, gravitate towards the organization of the species. Possibly it may be that the complex combination of proteids, common to chromatin and cytoplasm, is that part in which the constitutional characters inhere; while the phosphorised component, falling from its unstable union and decomposing, evolves the energy which, ordinarily the cause of changes, now excites the more active changes following fertilisation. This suggestion harmonises with the fact that the fertilising substance which in animals constitutes the head of the spermatozoon, and in plants that of the spermatozoid or antherozoid, is distinguished from the other agents concerned by having the highest proportion of the phosphorised element; and it

also harmonises with the fact that the extremely active changes set up by fertilisation are accompanied by decrease of this phosphorised element. It is useless to speculate, however. We can only say that the two functions of the chromatin do not apparently exclude one another; but that the general activity which originates from it may be but a lower phase of that special activity caused by fertilisation.[1]

Before fertilisation there occurs in the ovum an incidental process of a strange kind—"strange" because it is a collateral change taking no part in subsequent changes. I refer to the production and extrusion of the "polar bodies." It is recognised that the formation of each is analogous to cell-formation in general; though process and product are both dwarfed. Apart from any ascribed meaning, the fact itself is clear. There is an abortive cell-formation. Abortiveness is seen firstly in the diminutive size of the separated body or cell, and secondly in the deficient number of its chromosomes: a corresponding deficiency being displayed in the group of chromosomes remaining in the egg—remaining, that is (on the hypothesis here to be suggested), in the sister-cell, supposing the polar body to be an aborted cell. It is currently assumed that the end to be achieved by thus extruding part of the chromosomes, is to reduce the remainder to half the number characterising the species; so that when, to this group in the germ-cell, the sperm-cell brings a similarly-reduced group, union of the two shall bring the chromosomes to the normal number. I venture to suggest another interpretation more congruous with the ordinary course of Nature, namely, that gamogenesis begins when agamogenesis is being arrested by unfavourable conditions, and that the failing agamogenesis initiates the gamogenesis. Of numerous illustrations to be presently given, I will, to make clear the conception, name only one—the formation of fructifying organs in plants at times when, and in places where, shoots are falling off in vigour and leaves in size. Here the successive foliar organs, decreasingly fitted alike in quality and dimensions for carrying on their normal lives, show us an approaching cessation of asexual multiplication, ending in the aborted individuals we call stamens; and the fact that

[1] The writing of the above section reminded me of certain allied views which I ventured to suggest nearly fifty years ago. They are contained in the *Westminster Review* for April, 1852, in an article entitled "A Theory of Population deduced from the General Law of Animal Fertility." It is there suggested that the "spermatozoon is essentially a neural element, and the ovum essentially a haemal element," or, as otherwise stated, that the "sperm-cell is co-ordinating matter and the germ-cell matter to be co-ordinated" (pp. 490-493). And along with this proposition there is given some chemical evidence tending to support it. Now if, in place of "neural" and "haemal," we say—the element that is most highly phosphorised and the element that is phosphorised in a much smaller degree; or if, in place of co-ordinating matter and matter to be co-ordinated, we say—the matter which initiates action and the matter which is made to act; there is disclosed a kinship between this early view and the view just set forth.

sudden increase of nutrition while gamogenesis is being thus initiated, causes resumption of agamogenesis, shows that the gamogenesis is consequent upon the failing agamogenesis. See then the parallel. On going back from multicellular organisms to unicellular organisms (or those homologues of them which form the reproductive agents in multicellular organisms), we find the same law hold. The polar bodies are aborted cells, indicating that asexual multiplication can no longer go on, and that the conditions leading to sexual multiplication have arisen. If this be so, decrease in the chromatin becomes an initial cause of the change instead of an accompanying incident; and we need no longer assume that a quantity of precious matter is lost, not by passive incapacity, but by active expulsion. Another anomaly disappears. If from the germ-cell there takes place this extrusion of superfluous chromatin, the implication would seem to be that a parallel extrusion takes place from the sperm-cell. But this is not true. In the sperm-cell there occurs just that failure in the production of chromatin which, according to the hypothesis above sketched out, is to be expected; for, in the process of cell-multiplication, the cells which become spermatozoa are *left* with half the number of chromosomes possessed by preceding cells: there is actually that impoverishment and declining vigour here suggested as the antecedent of fertilisation. It needs only to imagine the ovum and the polar body to be alike in size, to see the parallelism; and to see that obscuration of it arises simply from the accumulation of cytoplasm in the ovum.

HERBERT SPENCER.

II

The Study of Variations

A Reply

"THE DIRECT ACTION OF THE CONDITIONS OF LIFE . . . IS A TOTALLY DISTINCT CONSIDERATION FROM THE EFFECTS OF NATURAL SELECTION; FOR NATURAL SELECTION . . . HAS NO RELATION WHATEVER TO THE PRIMARY CAUSE OF ANY MODIFICATION OF STRUCTURE."[1]

IF all writers on this subject would or could carry this passage from Darwin's writings branded in their minds, there would be no confusion in any question upon the Origin of Species. It is when Neo-Darwinians and others speak of Natural Selection either as a "cause," direct or indirect, of variation, in any sense of the word, or even, as Darwin said, an "aid" or "means," misconceptions will arise.

I do not know who Mr J. Lionel Tayler may be, but he has elected "to base his argument on [my] position." He is good enough to say that he does not "doubt the facts adduced, or even . . . assert that the conclusions are incorrect . . . but that . . . the arguments drawn from the facts do not . . . prove the position taken up."

I do not quite see, if the conclusions be correct, how the argument can be faulty!

He quotes my five summaries and proposes "to deal with the last conclusion first," viz.—"A new variety, and thence a new species, would be produced 'without the aid of Natural Selection' (Darwin)."

He says:—"It is still necessary to show not merely that all are similarly modified, but also that they are all equally thoroughly so, otherwise the variation that is most adapted will probably, or at least possibly, be selected, and Natural Selection will thus become a factor of some importance."

This passage shows incontestably that Mr Tayler has not yet grasped the purport of Neo-Lamarckism, which is precisely that embodied in the words of Darwin quoted, or the discovery of "the primary cause of modifications." There is no necessity whatever for all the individuals to be equally, though they be all similarly, modified. Natural Selection need not enter so timidly as he imagines, but may boldly kill off as many as it pleases, and thus "become a factor of some importance"; but this has nothing whatever to do with the primary cause of the origination of the definite

[1] "Animals and Plants under Domestication," vol. ii., p. 272.

variations. These being now known, it is at once seen that Natural Selection plays no part at all in causing them.

If I sow a quantity of seed of the wild carrot, radish or parsnip in a rich garden soil, and at the end of the season select and pull up all the individuals with roots having the same size as, or less than one-half larger in diameter than those of plants growing wild, leaving all with roots at least half as large again as the wild ones,—what has my selection and rejection of the former to do with the cause of the swelling of the roots of those individuals I consider to be the fittest to survive?

This, it appears to me, would pretty accurately illustrate Mr Tayler's and Neo-Darwinians' arguments.

Again, he says, "it is apparently assumed by Henslow that variations, being always definite, upset the Darwinian position." Such, at least, was the opinion of Romanes, who wrote me as follows:—"Of course, if you could prove that indiscriminate variations have not occurred in wild plants . . . you would destroy Darwinism *in toto*." No one can be called upon "to prove a negative," but I am told by many that my books do prove the contrary, that variations are definite. Darwinism is, of course, absolutely based on the supposed existence of indefinite variations, otherwise there would be nothing for Natural Selection to do for it.

Mr Tayler alludes to a prevalent "contempt for theory." I am not aware of such; but there undoubtedly exists a strong tendency to reject *à priori* assumptions, offered without a particle of fact. Thus, Mr Tayler writes:—"Assume that at any period, however remote, variations were completely indefinite," &c.; and then follows a paragraph full of assumptions containing the words "assume" twice, "suppose" once, "would" five times, "might" twice. It is, therefore, needless to follow him, as the paragraph consists solely of *à priori* statements (but no theory), for which he offers no basis of facts whatever.

The result of this argumentation on indefinite variations is a strange one, viz., that "Definite variations would be precisely what on *à priori* grounds would be expected."

If this be so, how was it that neither Darwin nor Dr Wallace ever expected them? Darwin admits them, but puts them on one side as rare or insignificant; while Dr Wallace said he did not even understand the meaning of the terms "definite" and "indefinite," until I pointed out that they were not mine but Darwin's own, and that the whole of Darwin's theory is based on the imaginary—unproven—assumption of plants always varying indefinitely in nature.

Darwin has really blended together two quite distinct things:—(1) The origin of actual variations in organisms, as they occur in nature; a physiological work which can be seen going on slowly or

quickly in nature, and more easily under cultivation; (2) the subjective idea of a "species," which is only a mental creation, of which Nature knows nothing.

A systematist calls slight variations from a given type "varieties," and as long as they are linked (and there are not too many of them) in a series, a_1 to a_6, say, a_6 is often regarded as much a variety as a_1; but if a_2 to a_5 be wanting, then he chooses to call a_6 a "species"; but his naming it as such makes no difference as to the origin of it. If Natural Selection has killed off a_2 to a_5, a_6 existed long before Natural Selection came on the scene, call a_6 what you please.

Natural Selection thus applied only separates varieties, and makes them more distinct for the benefit of the classifier.

With all this Neo-Lamarckism has nothing whatever to do. It is only concerned with tracing out the causes which originate or bring about the variations themselves. These are now palpably plain to all who can or will open their eyes bodily and mentally.[1]

I could criticise a good deal more in Mr Tayler's paper, but will only refer to the conclusion.

Mr Tayler proposes a new kind of Classification of Variations, viz.:—

Unadaptive Variations, i.e., "Wholly unfitted for their environment."

Indefinite Variations, i.e., "Varying in all directions round a central position."

Definite Variations, i.e., "All variations being of selective value, but that value varying in degree."

Adaptive Variations, i.e., "No selection, except from general strength."

In this last I seem to recognise my own position: and all I would ask Mr Tayler to do is to supply, say, half-a-dozen examples of plants and animals, living in a wild state, which he can place within the first three groups respectively. If he can do so—or he may reduce the number to three each, if he likes—then one may credit him with theorising; if he cannot, then the above remain as valueless *à priori* assumptions.

Until he and other modern Darwinians can see—with Darwin himself—that natural selection has nothing whatever to do with the Causes of Variations, but only with the distribution of plants and animals, in space and time, like Mr Tayler, I too "fail to see the use of continuing this discussion as it now stands" in his paper on The Study of Variations.

GEORGE HENSLOW.

[1] It is a great gratification to find, that while I have been busy with these questions in England, Mr J. Costantin has been studying them simultaneously on the Continent. His new work, "Les Végétaux et les Milieux Cosmiques," consisting of 280 pp. 8vo, embraces a great deal of what I have given in my books; but he also adds a great deal which I have not touched upon. His conclusions however, are absolutely identical with my own.

III

A New Method of Asexual Reproduction in Hymenopterous Insects[1]

ASEXUAL reproduction may manifest itself among insects at different stages in their life-history. Sometimes it is the larvae which reproduce new larvae by budding in the interior of their body (paedogenesis); at other times it is the adults which give birth to new individuals which develop in the ovaries of the parents (parthenogenesis). We have just discovered in the parasitic Hymenoptera a new mode of reproduction which completes this series of phenomena, of which it constitutes to some extent the first step; in *Encyrtus fuscicollis* which we have observed, it is in fact at the very beginning of the life-history, in the egg itself, that the dissociation of the body is produced, and it is at the expense of a single egg that we have just seen a very large number of embryos arise, perhaps more than one hundred, and all destined to become perfect insects which will be for the most part of one and the same sex.

Mr E. Bugnion had already observed that the caterpillars of the *Hyponomeuta* of the spindle-tree may, during June, contain chains of very curious parasitic embryos. These chains, of which only a single example is usually found in each caterpillar host, are formed on an average of from fifty to a hundred individuals arranged one after the other, enclosed in a granular mass similar to a vitellus and surrounded by a common long epithelial tube which is closed at both ends and floats in the lymph of the caterpillar by the side of the digestive tube. Bugnion followed the development of these embryos and observed that each of them gave birth to an *Encyrtus fuscicollis*. How and where does the *Encyrtus* accomplish its oviposition? What especially are the origin and significance of the common epithelial tube enveloping the chain of embryos? These are questions well adapted to excite the curiosity of the naturalist. Mr Bugnion thought that the *Encyrtus*, hatched in the spring, hibernated or exhibited a second generation with an unknown animal as its host; he assumed that, in any case, it must lay its eggs in packets during the month of May inside the caterpillar of the *Hyponomeuta*; as to the epithelial tube, it arose, according to him, from the enveloping

[1] Translated from a reprint from the *Comptes Rendus* of the Paris Academy of Sciences, Feb. 28, 1898, communicated by the Author.

membrane of the embryos secondarily separated from these latter and fused end to end. These deductions, although very plausible, are not really in accordance with the facts.

I have observed the oviposition of *Encyrtus fuscicollis*. Now, it does not lay its eggs in the month of May, but in the month of July only a few days after being hatched; moreover, its eggs are not deposited in the caterpillar but actually in the egg of the *Hyponomeuta* itself. The diminutive Chalcidian settles on a mass of eggs fixed for some hours, successively stroking with its ovipositor all or almost all the eggs in contact with it. I reserve the details of this operation, which I have observed at length, for a forthcoming memoir. I will only remark now, that the time occupied by the *Encyrtus* in laying its egg in that of the *Hyponomeuta* varies from half a minute to two minutes; almost as soon afterwards there follows another egg of the same laying, and so on for hours; then, when it has finished, it proceeds to another mass of eggs and begins the same manipulations again.

One important fact results from the foregoing observation. Given a limited quantity of eggs in the ovaries of an *Encyrtus*, it is practically impossible that, in the short time necessary for completing its oviposition, it should deposit in each moth's egg a number of eggs equal to that of the embryos composing one of the chains to which we have referred. A single egg must thus be laid in the egg of the *Hyponomeuta* and this single egg must split up into a great number of embryos.

This inference has been proved by direct observation. I have watched at the beginning of the evolution of the egg, and I have ascertained that from the first its enveloping membrane is constituted like that of other known Chalcidians; afterwards its cells multiply rapidly, and it lengthens in a way to form the epithelial tube. With regard to the cells which are found in the interior of the enveloping membrane, instead of resolving into a single embryo, as is the usual case, they dissociate in a way to give rise to quite a legion of little *morulae*, which later become embryos and arrange themselves in rows, as the envelope, increasing all the time, passes from the primitive vesicular form to that of a long flexuous tube. The whole product of the segmentation, however, is not devoted to the formation of embryos; from the beginning a cellular mass in the form of a crescent is seen on the periphery; this gradually increases in size and dissociates probably to form the granular mass which fills the enveloping tube and unites the embryos.

From the preceding observation therefore, there results the discovery, among the Arthropoda, of an entirely new method of reproduction to which I believe it is difficult to find anything analogous

among the Metazoa. How then can this curious case of metagenesis be interpreted? Can the tube containing the embryos be considered as the parent, of which the soma may be represented by the epithelial tube, and by the internal cells which do not take part in the formation of the embryos? One cannot help thinking of the cysticercans and orthonectids; but such comparisons may be rash at present. We prefer to confine ourselves to the facts, waiting for their general interpretation until the observations which we are pursuing on different species furnish us with more copious data.

PAUL MARCHAL.

IV

The Smallest of Stridulating Spiders

MANY readers of *Natural Science* will doubtless remember Mr Pocock's interesting paper, published some three years ago,[1] on "Musical Boxes in Spiders." In that paper Mr Pocock summarised our knowledge of the various organs which, in spiders, are specially adapted for producing sound. In all cases the sound or stridulation is due to the scraping of sharp spines on roughened surfaces, or on a series of ridges, or on stiff, thickened hairs; but the stridulating-organ may be developed in very different parts of the spider's body. For example, we may find:—

1. "Westring's organ"—A semi-circle of teeth on the forward part of the abdomen, scraping a set of ridges on the hinder part of the carapace. (Males of *Asagena*, *Pedanostethus*, and some other Theridiidae.)
2. "Campbell's organ"—A set of ridges on the femur of the palp, scraping a similar set on the outer surface of the mandible. (Males of *Leptyphantes*; imperfect in female.)
3. "Simon's organ"—A set of spines on the femur of the palp, scraping a set of ridges on the outer surface of the mandible. (Both sexes of *Thomisoides*.) A similar organ, in which, however, the femur of the palp bears only a single strong spine, has been since discovered in both sexes of *Scytodes* by Mr F. Pickard-Cambridge.[2]
4. "Wood-Mason's organ"—A set of stout spines on the mandible, scraping a series of club-like rods (thickened hairs) on the coxa (basal segment) of the palp. (Both sexes of *Poecilotheria*, *Selenocosmia*, &c.) This organ has recently been re-discovered by Mr Pocock (it had been described in 1867 by Blackwall, who was, however, ignorant of its purpose) in the South American *Trechona zebrata*.[3] Mr Pocock has also found the organ in the Australian *Idiommata blackwallii*,[4] while it has been described and figured in another Australian species—*Phlogius crassipes*, by Professor Baldwin Spencer.[5] A closely similar organ is stated by Mr Pocock to occur in species of the Ethiopian

[1] Vol. vi., 1895, pp. 44-50.
[2] *Ann. Mag. Nat. Hist.* (6), vol. xvi., p. 371.
[3] *Ann. Mag. Nat. Hist.* (6), vol. xvii., pp. 177-9.
[4] *Op. cit.* (6), vol. xvi., p. 225.
[5] *Rep. Horn Exped.*, vol. ii.; *Zoology*, pp. 412-14. [See *Nature*, vol. li., p. 438.]

genus *Harpactira*.[1] He believes, therefore, that it must have been independently developed in various groups of the Avicularíid spiders.

5. "Pocock's organ"—A set of spines on the coxa of the palp, scraping a series of club-like rods on the mandible. (Both sexes of *Phormingochilus*, &c.)

Since Mr Pocock published his paper in *Natural Science*, he has described two new stridulating organs in spiders. It may be of interest to summarise their structure:—

6. A large heart-shaped tooth on the anterior sclerite of the pedicel (narrow "stalk" between carapace and abdomen) scrapes a set of six horny, arched ridges situated in a cave-like hollow beneath the base of the abdomen. (Males of the New Zealand agelenid *Cambridgea antipodiana*.[2])
7. A set of spines on the hinder surface of the coxa of the palp plays on a series of modified hairs on the front surface of the coxa and trochanter of the first walking-leg. (Both sexes of *Eumenophorus* and allied Ethiopian avicularíids.[3])

Having briefly reviewed our knowledge of these organs, it is now my privilege to give an account of a very interesting "musical box," whose construction differs widely from that of any of the above:—

8. The inner hinder corner of the coxa in the fourth pair of legs is drawn out into a sharp point, scraping over the surface of the "lung-book" cover, which is traversed by a complicated series of ridges and furrows. (Male of *Entelecara broccha*.)

The spiders on whose sound-producing organs Mr Pocock has specially worked, are the Avicularíidae, some of the largest members of the order. The species in which I have observed the organ whose structure is summarised above, is, on the other hand, one of the tiniest of spiders; measuring only about 1½ mm. in length. For some years past I have been working up the arachnid fauna of Ireland, and a number of friends have been good enough to collect material for me in their rambles in different parts of the country. One of the most energetic of these is Mr R. Welch, of Belfast (whose geological photographs must be familiar to many readers of *Natural Science*). And it was he who found in October last, on the summit of Slieve Donard, the highest point of the Mourne Mountains, some 2790 feet above sea-level, the little

[1] *Proc. Zool. Soc., Lond.*, 1897, p. 771.
[2] *Ann. Mag. Nat. Hist.* (6), vol. xvi., p. 230.
[3] *Proc. Zool. Soc., Lond.*, 1897, p. 744.

spider which is provided with so interesting an organ of stridulation.

The spider is an addition to the Britannic fauna. It appears to be identical with a species described by Dr L. Koch from the Tyrolese mountains, under the name of *Erigone broccha*, and subsequently discovered near the Great St Bernard by Mr Simon, who[1] placed it in his genus *Styloctetor*. In his most recent revision of the spiders of this large and very difficult sub-family (Erigoninae), however, Mr Simon is disposed to reduce the number of genera, and now includes the species of *Styloctetor* in the large and comprehensive genus *Entelecara*.[2] We will refer to the spider therefore as *Entelecara broccha* (L. Koch). It is evidently a scarce alpine species, but there can be little doubt that it awaits discovery on other hills in our islands.

Probably the difficulty in determining this, to me, unknown spider led to the discovery of its stridulating organ, on account of the care-

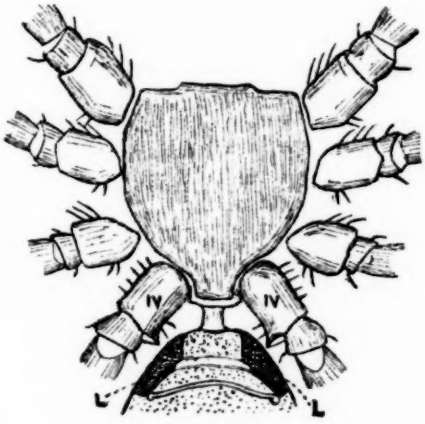

Fig. 1.

Fig. 2.

Fig. 1. *Entelecara broccha*.—Sternum and front portion of abdomen seen from beneath, showing the basal joints of the legs. The coxa (iv.) of the fourth pair produced inwardly into sharp spines which play over the ridged surfaces of the lung-book covers (L). Magnified.

Fig. 2.—Right lung-book cover seen from side, more highly magnified, showing parallel series of coarse ridges with transverse fine ridges (below), and irregular network of fine ridges (above).

ful examination of its structure which had to be made. When viewing the spider from beneath, the haunches of the fourth pair of legs were seen to differ markedly from those of the other pairs in the possession of a sharp point at the inner hinder angle (fig. 1). Such a sharp point is suggestive of a stridulating organ, but in this

[1] "Les Arachnides de France." Tome V. Paris, 1884.
[2] "Histoire Naturelle des Araignées." 2me edition. Tome I. Paris 1892.

position it could only play over some part of the hind-body or abdomen. Now, it is well known that in most spiders the hind-body is soft-skinned. The breathing organs or "lung-books," however, situated one on either side of the front end of the hind-body, are always covered by plates which are somewhat hardened. And microscopical examination soon showed that in the present spider these lung-book covers are completely chitinised, and that their surface is provided with a beautiful and complex arrangement of ridges and furrows. With the analogy of the stridulating organs of other spiders before us, there can be no doubt that the purpose of this apparatus is to produce sounds.

A more highly magnified view of a lung-book cover from the side is shown in fig. 2; and it will be seen that in the lower (ventral) region of the plate the ridges are somewhat coarse, and parallel, with numerous finer transverse ridges between them. But in the upper (lateral) region the ridges are all fine, and form an irregular network. It is likely that the note produced is relatively high or low, according as the fine or coarse ridges are brought into friction with the spine on the basal segment of the leg. Or it is possible that the irregular network may represent the primitive generalised sculpture of the surface of the lung-plate, and that only the parallel series of ridges are concerned in the production of sound.

Unfortunately, only a single male was obtained, so that it is impossible to say whether this organ is present also in the female. Its function is almost certainly to produce a sexual "call-note" or "love-song," for the apparatus is so minute that the pitch must be too high for the sound to be of use as a "warning-note." Many problems of interest are presented to the student of spiders by these stridulating organs. It is remarkable in how few forms comparatively they are present; and these by their structure and distribution are mostly seen to be ancient and decadent groups. How is it that species possessed of such wonderful and complex structures have been, to a great extent, thrust aside in the battle of life by rivals which have no such organs?

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V

Parasites and Mess-mates in Ant-hills[1]

THE nests of ants, by their well-chosen situation, the great accommodation they offer, and the security they provide, for obvious reasons attract a certain number of animals which can in reality live perfectly well elsewhere. It is always necessary, in order that these animals may thus live associated with the ants, that they should not constitute a favourite food (*Porcellio, Lucasius*), or that they should possess some mechanical protection (*Glomeris*), or offensive glands as the myriopod *Blaniulus*, or secret glands like the hemipteron *Dictyonota*, or that they should be able to escape the ants by their small size or their agility (Thysanura).

The warmth in the nests, even during the hibernation of the colony, helps to attract a certain number of animals. It is no doubt on account of the warmth thrown off by the ants that one finds in Siberia, in the nests of *Formica rufa*, the same species of beetles as in Europe. *Cetonia floricola*, whose larva lives in the deeper parts of the nest of *Formica rufa*, spins its cocoon in the upper part of the dome in order to gain, during its nymph-stage, the heat which is there generated by the heat of the sun. *Quedius brevis*, which, during the fine season, feeds on *F. rufa* or *Lasius fuliginosus*, but which is compelled to hide itself to escape their pursuit, installs itself during the winter in the middle of the mass of torpid ants.

The vegetable nourishment to be found in ants' nests explains the presence of some animals, as, for instance, that of some Isopods. The woody material of which *F. rufa* and related races construct their nests serves as nutriment to certain caterpillars of micro-lepidoptera (*Myrmecocela ochraceella*). The same applies to the larvae of certain Coleoptera which live in the nests of ants, as, for example, the larvae of *Cetonia* or those of *Clytra*, which, utilising their excretions for the manufacture of a kind of cardboard, make of it protective sheaths for themselves.

But it is the animal nourishment in particular, furnished by the remains of insects devoured and by the carcases of ants themselves, which attracts to the nests a large number of myrmecophila. Such is the case with many Acarids (*Laelaps*) and Coleoptera of the

[1] Abstract of Charles Janet, "Rapports des Animaux Myrmécophiles avec des Fourmis" (Limoges: Librairie Ducourtieux, 1897. 8vo, pp. 100).

family Histeridae (*Hister*, *Hetaerius*, *Myrmetes*) and the Staphylinids *Stenus* and *Dinarda*. The progeny (eggs, larvae, and nymphs) which is sometimes so abundant in the nests, and which ants themselves, in case of scarcity, draw upon as if it were ordinary provision, can also be utilised by the myrmecophiles; wounded larvae or those bitten by ants are often devoured by the beetles *Platyarthrus claviger* or *Atemeles*.

The cloaca of the nests furnishes a good means for the development of certain Nematodes and for the nourishment of detriticolous Sarcoptides.

Generally, it is more often the assemblage of advantages, and not only one of those which are here cited, which has been the motive of introduction and definite installation of a myrmecophile in the home of a species of ant.

The advantages that a myrmecophile can find in the home of one species are not the same as can be found in the home of another species. For this reason we see *Atemeles* inhabit successively the nests of two different species: the nest of a *Myrmica* during the bad season until pairing time, then the nest of *Formica* to which they confide their progeny, and with which they themselves live to the end of their existence.

The nutritive liquid stored in the maw and worked up later with the addition of the product of the pharyngeal glands is a precious nourishment, nearly always available in abundance, and likely to be snapped up, in passing, whilst the ant disgorges for its comrades. This naturally attracts some animals. It is the case with the Lepismidae (*Lepismina polypoda*) which do not appear to be tolerated amicably by their hosts. More favoured than these Lepismids, the Acarids (*Antennophorus uhlmanni*) which support themselves on the same substance, have been accepted by the ants so far as to be permanently carried, and that in spite of their relatively large size.

It is this same liquid that is immediately and generously given from the ants to the myrmecoxies, as, for example, to *Atemeles*, which demand it by raising their anterior feet, or to *Claviger*, which strike with their antennae for it on the head of their host.

The product of the pharyngeal gland which plays an important part in the working up of the liquid, is the best nourishment for nematode larvae (*Pelodera*).

The viscous substance deposited on the surface of the eggs is perhaps used as nourishment by the nymph of *Laelaps oophilus*, which settles itself upon the packets of eggs in the nest of *Formica sanguinea* and *F. rufibarbis*.

A predisposition of ants to give to the progeny of certain myrmecophila the same care as to their own, has led to the definite main-

tenance in the nests of a certain number of forms. *Lomechusa* passes all its life with *Formica sanguinea*, which cares for the larvae of this beetle as much as for its own.

The search for the liquids secreted by Aphides does not usually constitute a true case of myrmecophily. But it is possible that a certain number of species of Aphidae have been so well cared for by ants, and have found such advantages from this care, that they have finished by no longer being able to live outside the ant nests, and have thus become veritable myrmecophiles.

It is probable that the search for certain coleoptera and the solicitudes with which they have been the object outside the nest, have been the origin of their myrmecoxeny (Thorictidae, Paussidae, Clavigeridae).

The presence of Aphides in the nests of ants attracts aphidophagous animals, which thus become indirectly myrmecophile (larva of the Coccinellid *Brachyacantha ursina*).

The blood of ants is sucked by Acarids (*Discopoma comata*) which perforate the abdominal membranes of their hosts, making slight wounds.

The incessant activity of all ants, the habits that certain of them have of making long journeys, have led a goodly number of myrmecophila to use them for transport.

The hairs of ants furnish to acarids who wish for transport an easy method. This is the case with *Uropoda cristiceps*, which, frequently enough, keeps itself firmly attached to one of these hairs on the extremity of the abdomen of *Formica fusca*.

The tibial comb, so important an organ to an ant, presents the interesting peculiarity of being used by an Uropode which, for this reason, bears the specific name of *philoctena*.

The stem of the antenna furnishes a convenient hold for a *Thorictus*, which crowds itself into a circular space formed by a hollowing of the epistome and by the mandibles, and is thus carried about as much in the interior of the nest as in the emigration from one district to another.

Myrmecophila, for purposes of transport, can also fix themselves upon the bodies of ants and hold on by various methods. *Claviger* fixes itself upon the back of *Lasius*, and gripping firmly with its claws, is, in case of danger, rapidly carried from the superficial to the deep galleries of the nest. An oniscid, noticed by Lund, gripped with its claws under the abdomen of *Myrmica typhlops*. *Antennophorus* remains permanently on the body of the ant, and adheres by adhesive caruncles terminating the six ambulatory feet. *Iphis equitans*, which is frequently upon the head of *Tetramorium meridionale*, does not remain permanently in that position, but descends quickly to the body and gets a fresh hold upon that. The nymphs of an Uropode near to *U. ovalis*, glue themselves with an anal mucus to the dorsal

crest of the femur of the second foot of *Lasius mixtus*, in the same manner as the nymphs, and similar species, glue themselves upon other insects.

The transport of the progeny of ants is also utilised by certain myrmecophila, which are secure in fixing on to the eggs, larvae, nymphs, or cocoons, to remain near the ants and to be installed in a safe place and in the best parts of the nest. This is perhaps the case with *Laelaps oophilus*, which fixes itself on the egg packets: it is with that of *Claviger* which so frequently fixes itself upon the larvae, with *Antennophorus* which fixes sometimes upon the nymphs, with *Uropoda cristiceps* which can fix itself momentarily upon a cocoon by holding a fold closely between the coxa of its antenniform feet.

The means of defence of ants serve indirectly to protect animals which live in their nests. They serve, indirectly again, to protect those animals which mimic the ants, whether myrmecophilous or not. Myrmecoid animals can be protected by this resemblance, for example, against insectivorous birds which do not eat ants. This mimicry may be more or less pronounced. There are plenty of examples among the Araneids (*Salticus myrmicaeformis, Myrmecia vertebrata*), among the Orthoptera (*Myrmecophana fallax*), the Heteroptera, in which a certain number have the larvae at the same time both myrmecoid and myrmecophagous, and among the Coleoptera (*Clerus formicatus* and *Myrmecomoca*).

Thanks to their means of defence, ants are not attacked by certain animals, or can defend themselves perfectly against them. Thus, even with animals which are powerfully armed, such as spiders, ants often come off victorious in a hand to hand conflict.

In spite, however, of the means of defence that they possess, ants by reason of causes which in other respects are a power to them, have become the normal prey of a great number of enemies. The length and frequency of their travels expose them to danger from the funnels dug in the sand by the larvae of Neuroptera (*Myrmeleon formicarius*) and by dipterous larvæ (*Lampromya miki*). They are also liable to be seized by beetle larvæ (*Cicindela*) hidden in vertical holes, and to become entangled by the antennae in the capture threads that certain spiders (*Theridion riparium*) attach to the ground. Their method of travel in single file, the hindrance in this case that is caused by the heavy burdens they carry, also exposes them to be carried off individually by spiders like *Zodarion elegans*, exactly as a man in a column of porters is sometimes carried off by a tiger. Again, at the time of egress, and especially whilst they are absorbed in the excitement of battle, ants are exposed to the attacks of certain Hymenoptera, of which the offspring are entomophagous (eggs of *Elasmosoma berolinense* are deposited in the abdomen of *Formica rufa*).

Sleep, so necessary to animals which expend so much energy, and the noctural torpor, occasioned by cold, put ants at the mercy of myrmecophagous coleoptera. One of these is *Myrmoecia fussi* of the nests of *Tapinoma erraticum*, which hides itself during the day to avoid the formidable poison of these ants, but which seizes and devours them during the night.

During their winter sleep ants are without means of defence. It is said that the bird *Picus viridis*, which supports itself chiefly on insects, digs up the nests of *Formica rufa* in the winter and eats the torpid inhabitants.

The great multitude of individuals, and the almost incessant renewal of the progeny, which contributes so much to the power of ants, allows them, on the other hand, to become an easily found prey for those animals which are stronger than themselves, or are so organised as not to suffer from their means of defence. Thus it is that ant-bears, birds, and toads destroy a considerable number of ants.

Ant larvae, in common with the larvae of so many other insects, receive the eggs of entomophagous Hymenoptera, which develop at the expense of the tissues of their victim and undergo their nymph-stage in the cocoon of the ant (*Euchoris myrmeciae*, the entomophage of *Myrmecia forficata*). The difficulty that the entomophagous Hymenoptera have in penetrating to the interior of the nests, explains the fact that the ant larvae do not more often fall victims to them.

Finally, the abundance of progeny which is to be found in ants' nests constitutes a choice of nutriment to every animal which seeks first. Thus *Solenopsis fugax*, thanks to its small size, is able to penetrate the nests of other species of ants to devour the nymphs.

Societies of ants are rendered powerful by the number of individuals that compose them; by their tenacity, courage, and complicated instincts; by the perfect means of attack and defence possessed by certain individuals; by the favourable medium and the protection that is afforded by their well-shielded retreats; and by a remarkable division of labour. On account of all these particularly advantageous circumstances, colonies of ants as a rule enjoy a long existence and a life of opulence.

VI

The History of the Mammalia in Europe and North America

THE story of the development of the races of warm-blooded quadrupeds, or Mammalia, in the northern hemisphere, during the Tertiary period, is one of the most interesting and important chapters in philosophical natural history. It is true that only the barest outlines of the subject have hitherto been revealed; but sufficient is known to arrive at some general conclusions which are not likely to be affected by future discoveries.

Mesozoic

The earliest known animals exhibiting any close approach to the Mammalia in the structure of their skeleton date back to the close of the Primary or Palaeozoic Era. They are five-toed quadrupeds, with most features which now characterise cold-blooded animals of the class of reptiles; but in several respects their skeleton resembles that of the lowest surviving mammals—the monotremes of the Australian region—while their dentition is often differentiated into cutting teeth in front (like incisors), grasping teeth at the corners (like canines), and grinding or crushing teeth at the sides (like molars). In allusion to the latter peculiarity they are usually known as Anomodontia. During the Permian and Triassic periods these animals flourished both in the northern and in the southern hemisphere; but before the dawn of the Jurassic they seem to have become extinct in all parts of the world which have hitherto been geologically examined. It is probable, indeed, that in some isolated region some of them passed into mammals about that time; for in the Jurassic rocks both of Britain and North America there are occasional remains of small mammals as large as rats, and the most plausible explanation of these is, that they were accidental escapes from some other land with a more advanced fauna, just as are the rats and mice of the present day in the comparatively antique realm of Australia. Another group of diminutive mammals of the Jurassic type occurs in the Upper Cretaceous (Laramie Formation) of North America; while quite at the base of the Tertiary Formations, both in North America and Europe, true placental mammals begin to appear, and very soon become the dominant animals of the land.

Base of Cainozoic or Tertiary

The members of this earliest Tertiary mammal fauna, so far as can be determined from fragments, are remarkably similar on the two sides of the Atlantic Ocean. Their remains are found in a lake-deposit, the so-called Puerco Formation of New Mexico, and in the Cernaysian Formation near Rheims, in France. Among them there are still some survivors of the typically Jurassic and Cretaceous mammals of the order Multituberculata—diminutive creatures, with jaws approaching those of the rodents in pattern, and with the crowns of the molar teeth bearing numerous tubercles for crushing. These mammals are now generally supposed to have had the same lowly organisation as *Ornithorhynchus* and *Echidna*; and if so they were the last survivors of the Monotremata outside the Australian region. The greater part of the Puerco and Cernaysian fauna, however, consists of small mammals with a diminutive smooth brain, which might have served very well for the ancestors not only of the modern placental mammals, but also of the lowly pouched mammals, or marsupials, now characteristic of the Australian region, and also met with in tropical America. Some of these ancestral types exhibit teeth and other features very suggestive of the lemurs, and might easily have been modified into the latter; others look a little like ancestral rodents; others are clearly at the base of the insectivorous and flesh-eating mammals of the orders Insectivora, Chiroptera, and Carnivora; while a large number are the little modified forerunners of the hoofed animals.

Eocene

The next early Tertiary mammal fauna, characteristic of the Lower Eocene period, is also nearly identical in Europe and North America. In England it has been found in the Thanet Sands, London Clay, and Woolwich and Reading Beds. In North America it occurs in lake-deposits termed the Wasatch Formation. A few diminutive typical marsupials, apparently almost identical with the opossums which still live in the forests of tropical America, occur in this fauna on both sides of the Atlantic. The ancestral hoofed animals, or Condylarthra, are now more varied and attain larger dimensions than they did previously; and some of them seem to have already evolved into odd-toed (perissodactyle) and even-toed (artiodactyle) members of the order. There are thus recognisable ancestors of the horses and the pigs. The most characteristic feature of this fauna, however, is the rise of a tribe of stout animals about as large as tapirs, with five short stumpy toes on remarkably small feet, hence named Amblypoda or Amblydactyla. *Coryphodon* represents this tribe both in Europe and North America.

It is harmless, exhibits a ridiculously small brain-cavity, and has a complete series of teeth adapted for feeding upon succulent vegetation. With the hoofed mammals, there are also the primitive smooth-brained flesh-eaters again, or Creodonta, as they are termed. There are likewise true rodents and undoubted examples of lemurs.

In the next, or Middle Eocene period, the lowly organised but overgrown Amblypoda seem to have become extinct in Europe; but they have assumed still larger proportions and fantastic shapes in North America. Here, at any rate in a limited area, they are now terribly horned animals, or Dinocerata, with three pairs of bony bosses on the top of the head, and a great pair of tusks hanging downwards from the upper jaw. They seem to have reached the maximum development for animals with such small brain-capacity, so they immediately become extinct. The true odd-toed and even-toed hoofed animals in which the brain gradually enlarges and begins to show complications, are much more flourishing and quite a conspicuous race. In North America, indeed, one family (Titanotheriidae) arises and soon includes animals as large as small elephants. The Creodonta are also more varied than before, and flying mammals or bats are now completely formed.

The Upper Eocene fauna is still more advanced, and the differences between the mammals of the Old and New Worlds begin to be more and more marked. The Creodonta are now of less importance than before, and true Carnivora much like modern dogs are met with for the first time at least in Europe (*Cynodictis*). The ancestral hoofed animals, or Condylarthra, are also few. The odd-toed hoofed animals, or Perissodactyla, are still numerous, and the most important new form is *Palaeotherium* in Europe; but the Artiodactyla attain the most remarkable development both in Europe and North America. On the former continent there are the pig-like *Choeropotamus*, and the primitive forerunners of the ruminants, *Hyopotamus* (*Ancodus*) and *Xiphodon*; while a remarkable short-lived family exhibiting three-toed spreading feet is represented by *Anoplotherium* and *Diplobune*. In America there are the Oreodonts (*Protoreodon*) and primitive camels (*Leptotragulus*), which must have been still more nearly ruminants. The Rodentia are now very numerous and varied; on the other hand lemurs appear for the last time on both continents. The opossums (*Didelphys*) are still abundant. Marine mammals occur for the first time, the primitive whale, *Zeuglodon*, being found in Europe, Northern Africa, and North America; while a single Cetacean vertebra of a more modern type has been discovered in the Upper Eocene of Hampshire. There is also some fragmentary evidence of Sirenia in northern Italy.

It must be added that the European Upper Eocene mammalian

fauna is best represented in certain phosphate-bearing earths or phosphorites filling an extensive series of fissures in the district of Quercy, between Villefranche and Montauban, in the south of France. These fissures, however, were evidently open and being filled with earth and bones long after the close of the Eocene period, so that two or more successive faunas are mixed together, and it is not possible to determine with certainty the age of any particular fossil found in this anomalous deposit. A similar mixture of Eocene and Miocene mammalian fossils, though of a more fragmentary character, also occurs in several fissure-accumulations of iron-ore (the so-called bohnerz) in Switzerland (as at Egerkingen), in Würtemberg (as at Frohnstetten), and in Bavaria (as at Pappenheim).

Miocene

Between the Eocene and Miocene strata of Europe, stratigraphical geologists who base their conclusions on the marine deposits, recognise an intermediate formation termed Oligocene. So far as the vertebrate faunas are concerned, however, it does not seem possible to admit this division, and the so-called Lower Oligocene falls more naturally into the Upper Eocene, while the Upper Oligocene may be included in the Lower Miocene.

Adopting this arrangement, the Lower Miocene vertebrate fauna of Europe occurs in the Hempstead Beds which directly overlie the Upper Eocene in the Isle of Wight; in the lacustrine marl of Ronzon, near Puy-en-Velay, and of other districts in southern France; in other freshwater deposits near St Gérand-le-Puy, Allier; in the lignites of Rott, near Bonn, of La Rochette, near Lausanne, and of Cadibona, in Liguria; in the marine Rupelian formation of Belgium; in marine, brackish-water, and freshwater deposits in the neighbourhood of Mayence; and in other freshwater formations near Ulm, Würtemberg. A corresponding mammalian fauna in North America occurs in the White River Formation, which was deposited in an extensive series of lakes spread over Nebraska, Dakota, Colorado, Wyoming, and part of southern Canada. The Creodonta are now found for the last time both in Europe and North America, and seem to be represented only by one highly specialised genus, *Hyaenodon*. The true Carnivora are abundant and varied, including even a cat (*Eusmilus*) on both continents; but the viverroids are confined to Europe. Among hoofed animals the Perissodactyla include hornless rhinoceroses on both continents; while there is a considerable advance in the line of the horses in North America, and *Titanotherium* represents the highest and last development of the peculiarly American family of Titanotheriidae. Some of the primitive Artiodactyla attain a large size and become of importance,

such as *Anthracotherium*, *Hyopotamus*, and *Elotherium*, both in Europe and America. The early ruminants are also represented in Europe by such genera as *Caenotherium* and *Amphitragulus*; while they occur in still greater variety in North America as Oreodonts (*Oreodon* and *Agriochoerus*), primitive camels (*Poebrotherium*), and strangely horned quadrupeds (*Protoceras*). The opossum (*Didelphys*) appears for the last time in Europe; so also do the modern American freshwater ganoid fishes, *Amia* and *Lepidosteus*. Among marine mammals, *Halitherium* and *Miosiren*, from the neighbourhood of Mayence and Antwerp respectively, are the earliest well-known examples of the Sirenia.

The Middle Miocene fauna is well known from numerous localities in Europe, and of these some of the more classical may be enumerated as follows: Sansan, Simorre, and Villefranche d'Astarac, in Gers, France; Léognan and Romans, Gironde; St Gaudens, Haute Garonne; La Grive-St-Alban, Isère; Montpellier, Hérault; Käpfnach, Chauxdefonds, and Elgg, in Switzerland; Georgensgmünd and Steinheim, in Würtemberg; and Monte Bamboli, in Tuscany. In North America the John Day Formation of Oregon and Montana is supposed to furnish a nearly equivalent, though distinctly more ancient assemblage of mammals. The most remarkable feature of this fauna in Europe is the sudden appearance of the elephants or Proboscidea (*Dinotherium* and *Mastodon*) and the true apes (*Oreopithecus*, *Dryopithecus*). It is also interesting as comprising the earliest known deer with antlers (*Dicrocerus*), and the earliest rhinoceroses with a horn. The Carnivora are noteworthy as including a series of genera intermediate between the dogs and bears (*Amphicyon*, *Hyaenarctos*). In North America there are not as yet any traces of the Proboscidea, or of deer with antlers; while the chief Carnivora of the John Day Formation are the sabre-toothed cats (*Nimravus*).

There is no clearly distinguishable Upper Miocene mammalian fauna in Europe, though the lacustrine deposits of Oeningen, Baden, may perhaps represent this stage. In North America, however, the mammals from the Loup Fork Formation are usually described as Upper Miocene; and the assemblage or fauna certainly exhibits a mingling of the types which are partly Middle Miocene, partly Lower Pliocene, in Europe. The Loup Fork series is chiefly of lacustrine origin, and very widely distributed between South Dakota and Mexico. *Mastodon* now appears for the first time in the New World, but it is not accompanied by *Dinotherium*. The rhinoceroses are still hornless. Besides other genera of primitive horses, *Hipparion* is found. Deer with small antlers are also met with (*Cosoryx*); while *Procamelus* makes a very close approach to the camels, which appear in India in the Pliocene.

Pliocene

The Lower Pliocene vertebrate fauna of the Old World is well known, not only from several widely-distributed localities in Europe, but also from parts of Asia and Algeria. Among marine mammals the Sirenian *Halitherium* and the primitive Cetacean *Squalodon* still survive; but the large majority of the remains found in the marine Antwerp Crag of Belgium, the Red and Coralline Crags of eastern England, and the equivalent sub-Apennine strata of Italy, represent genera of whales and seals closely similar to, or even identical with, those now living. The land-mammals are very numerous, and are best known from the freshwater deposits of Mount Léberon and Cucuron (Vaucluse) and Montpellier (Hérault) in France; from Concud in Spain; from the estuarine yellow sands of Eppelsheim, Hesse Darmstadt; from the Vienna basin and Baltavár in Hungary; and from a torrent-deposit at the foot of Pentelicon in the ravine of Pikermi, near Athens. Abundant remains are also found in a volcanic tuff on the Island of Samos in the Turkish archipelago; in a similar deposit at Maragha in Persia; and in the well-known Siwalik Formation of India. There are, moreover, traces of the same fauna in China, Japan, the Philippines, Borneo, and Java. In the European area true apes are represented by a single thigh-bone from Eppelsheim, and by numerous skeletons of *Mesopithecus* from Pikermi. Among Carnivora, *Felis* and *Hyaena* appear for the first time, associated with *Ictitherium*, which seems to be an ancestor of the latter; primitive types of bears (*Amphicyon*, *Hyaenarctos*) are also common, but *Ursus* itself is not yet found. *Dinotherium* is now met with for the last time, and *Mastodon* flourishes; but there is as yet no true *Elephas*. Antelopes abound, except in the comparatively northern region of Hesse Darmstadt, and there are several ancestral types of giraffe (*Palaeotragus*, *Helladotherium*). Typical pigs (*Sus*) are first found; and the very abundant *Hipparion* makes a close approach to the modern horses.

The North American fauna which seems to represent the Lower Pliocene is as yet very imperfectly known. One of the lacustrine deposits containing it, however, clearly rests unconformably upon the Loup Fork Formation, at least in one part of Texas. The hornless rhinoceroses now appear for the last time, species of *Mastodon* and true *Equus* occur, and there are also llamas and peccaries.

The latest (Upper) Pliocene mammalian fauna of Europe is nearly similar to that of the Pleistocene, most of the genera being identical and the species only slightly different. It is best known from freshwater deposits in the Val d'Arno, Tuscany; from a torrent-deposit at Olivola in the Carrara mountains; from Perrier,

Ardé, Peyrolles, and other localities in the Puy-de-Dôme, France; from Roussillon and Montpellier (Hérault), where the Lower and Upper Pliocene faunas are not quite clearly distinguished; and from the Norwich Crag of Norfolk. There are still traces of the apes in southern France. Among the Carnivora, *Hyaenarctos* is just becoming extinct, and is being replaced by small bears of the genus *Ursus*; while the species of sabre-toothed tiger, or *Machaerodus*, are now very large. The true beavers (*Castor*) and other characteristic modern genera of Rodentia appear for the first time, and there is a large beaver-like animal, *Trogontherium*. *Mastodon* occurs for the last time, and *Elephas* now appears with the gigantic *E. meridionalis*. There are also true oxen (*Bos*, *Leptobos*) and deer of existing genera (*Cervus*, *Cervulus*); while a typical hippopotamus, as large as the recent *H. amphibius*, is not uncommon. The tapirs have already disappeared, but rhinoceroses survive (*R. etruscus*); and for the first time there is a completely evolved one-toed horse (*E. stenonis*).

The Cromer Forest Bed

At the close of the Pliocene period Britain was still connected with the adjoining continent, and an interesting remnant of the mammalian fauna of this part of Europe at the time is preserved in an old land surface and associated deposits now exposed in the cliffs of Norfolk, especially in the neighbourhood of Cromer. This is the so-called Forest Bed Series. The mammals found here are chiefly those of the typical Pleistocene fauna; but a few still survive from the Upper Pliocene, such as a gazelle, some deer with very large antlers allied to the *Cervus dicranius* of the Val d'Arno, *Rhinoceros etruscus*, *Elephas meridionalis*, and *Trogontherium*. The Forest Bed fauna is thus intermediate in character between the Pliocene and the Pleistocene; and a similar mingling of forms has been observed in certain local deposits both in France and Italy.

Pleistocene

The Pleistocene mammalian fauna of Europe is very remarkable. It does not include many forms which have subsequently become extinct; but throughout the central and north-central parts of the continent there is a curious mingling of northern, eastern, and southern types which it seems difficult to explain. The remains of this fauna are met with in the surface deposits and caverns of Britain, so far north as Yorkshire, quite as abundantly as on the continent; so that the bed of the North Sea and the Straits of Dover must still have been an open valley, and our island remained part of the mainland. The northern animals include the reindeer and musk-ox, which wandered as far south as the Pyrenees; the

typically eastern animals comprise the saiga antelope, the jerboa, the tailless hare, and *Myogale moschata*; while among the numerous southern types may be mentioned the lion, leopard, hyaena, and hippopotamus. The principal forms which have since become extinct are *Machaerodus latidens*, *Ursus spelaeus*, *Cervus giganteus*, *Trogontherium cuvieri*, *Elephas primigenius*, *E. antiquus*, *Rhinoceros antiquitatis*, and the great remarkable Russian rhinoceros, *Elasmotherium sibiricum*. Of these latter, the so-called Irish deer (*Cervus giganteus*) is the only one which seems to have survived until the dawn of historic times.

The Pleistocene deposits of North America yield much fewer mammals than those of Europe; but there is a similar mingling of northern and southern types in the central region. It is also interesting to note that one of the commonest skeletons represents the latest known species of *Mastodon* (*M. americanus*). The mammoth, musk-ox, reindeer, elk, and bison are present; bears have now arrived, and the lion may also perhaps be represented; but *Equus* has already become extinct, and there are no traces of the woolly rhinoceros (*R. antiquitatis*), the cave bear, or the hyaena. In the surface deposits of the southern United States some of the typically South American edentates occur (*Megatherium*, *Mylodon*, *Glyptodon*), these having apparently wandered northwards on the emergence of the isthmus of Panama in the early part of the Pliocene period.

North American v. Old World Mammals

Having thus traced the series of mammalian faunas through the Tertiary formations both of the Old World and of North America, it is interesting to speculate as to where the various elements arose. At the base of the Eocene it is evident that the faunas of the east and the west were essentially identical. As they are traced upwards they gradually diverge.

The first noteworthy difference is the great development of the Condylarthra in America, and the rise in the Eocene of the large specialised Amblypoda, of which only a single genus (*Coryphodon*) has been found in the corresponding fauna of Europe. On the other hand, the still larger hoofed animals of the sub-order Proboscidea seem to have originated in the Old World, and did not reach America until the late Pliocene.

The Perissodactyla—the tapirs, rhinoceroses and horses—appear to have advanced on a parallel course on the two continents; though in America both the rhinoceroses and horses became extinct at the close of the Pliocene, the former without acquiring the characteristic horn.

Among Artiodactyla, both the deer and pigs seem to have been

approximately parallel in their development on both continents, only differing in some minor branches which soon became extinct. The camels, however, are clearly American throughout, only wandering into the Old World by Asia in the Pliocene. It is almost equally probable that the oxen originated in the Old World.

Among Carnivora, the Creodonta are both American and European; but on the former continent they only pass upwards into the dogs (Canidae), weasels (Mustelidae), and the aberrant cats of the family Nimravidae, while in Europe they are succeeded not merely by these families, but also by the Viverridae, Hyaenidae, Felidae, and Ursidae. The viverroids and hyaenas never reached America, but the true cats and bears arrived in that continent at the close of the Pliocene.

Of the Primates, the primitive lemuroids appeared in the Eocene similarly on both continents; but in North America they soon became extinct, while in the Old World they were followed by the true apes, and still have some specialised survivors.

A. SMITH WOODWARD.

VII

Wachsmuth and Springer's Classification of Crinoids [1]

A LITTLE less than a year ago was published the largest book that has ever been issued all at one time on a crinoid subject. It represents a portion of the final results of over thirty years work by the late Charles Wachsmuth, in collaboration for the last twenty years with Frank Springer. These authors have long been recognised as the leading authorities on Palaeozoic crinoids, a position won chiefly by their most valuable "Revision of the Palaeocrinoidea," published by the Philadelphia Academy of Natural Science. That work, however, was but a paving the way for a greater enterprise, namely, the monographing of all the Palaeozoic crinoids of North America. This task can never be accomplished by them, though it is to be hoped that the survivor may find opportunity to give us the fruits of his knowledge in the remaining branches of the subject. The present volumes are occupied mainly with the systematic account of the North American representatives of those crinoids known as Camerata or 'vaulted' crinoids; but they contain also introductory and morphological parts, dealing with the Crinoidea as a whole. The points raised are so many, often so novel, and the treatment of them so important, that it would be impossible to discuss them adequately in a single article. On the present occasion I shall merely attempt a critical account of the authors' classification of the Crinoidea.

A crinoid reduced to its simplest elements consists of three principal portions—(i.) a theca or test enclosing the viscera; (ii.) five arms stretching upwards or outwards from the theca, sometimes single, sometimes branching; (iii.) a stem stretching downwards from the theca and attaching it to the sea-floor. The theca and arms together are called the 'crown'; that part of the theca below the origins of the free arms is called the 'dorsal cup'; while the ventral part above the origins of the arms, serving as cover to the cup, is known as the 'tegmen.' All these parts are supported by plates or ossicles of crystalline carbonate of lime, deposited in the meshes of the lower layers of the integument. In many cases the skeletal tissue or

[1] The North American Crinoidea Camerata. By Charles Wachsmuth and Frank Springer. Mem. Mus. Comp. Zool. Harvard, vols. xx. and xxi., 837 pp. and 83 pls. Cambridge, U.S.A., May 1897.

'stereom' forms by far the greater part of the whole animal; even the walls of the theca may be so strongly calcified that one marvels how the creature lived with so little space in which to pack its nerve-centre, stomach, and other vital organs. Some of the early cystid ancestors of the crinoids had no stem or arms, but merely a theca like an irregularly plated sac, affording little information as to the structure of the animal beyond the position of mouth, anus, water-pore, and generative opening. But in the crinoid, concomitantly with the development of stem and arms, a more regular arrangement of the thecal plates arose, and the various skeletal elements became more intimately connected with the organs of the body. It is not difficult for us, by comparison with recent forms, to get a fair idea of the internal anatomy of the most ancient crinoids. We can predicate the course of the nerves or the intimate structure of the tissues connecting the plates in any extinct type of crinoid, with no less correctness than the anatomist of Vertebrata can infer the position of the muscles in an Eocene ungulate; and it is doubtful whether our conclusions would be modified in any important point had the subjects of our study been preserved to us by the most approved laboratory methods instead of as petrifactions.

The cup, in its simplest form, consists of two circlets of five plates. Each plate of the upper circlet supports an arm and is called a 'radial'; the plates of the lower circlet, the 'basals,' rest on the stem and alternate with those of the upper circlet, *i.e.*, are inter-radial in position. Some crinoids have yet another circlet below these, and the constituent plates are called 'infrabasals'; they are radially situate. The tegmen in most primitive forms, as well as in the embryonic stages of the living *Antedon*, consists of five large triangular plates, alternating with the radials, and called 'orals,' because they roof over the mouth. Between one of the orals and the two adjoining radials there usually opens the anus, while this same posterior oral is pierced by one or more water-pores. The arms consist of a series of ossicles, called 'brachials'; each is joined to the radial by a muscular articulation, permitting of motion up and down, while each brachial is usually united to its successor by a similar articulation. The arms usually fork more than once, and the brachials after the radial and after each successive forking are termed brachials of the first order, of the second order, and so forth, or, as I have found more convenient, 'primibrachs,' 'secundibrachs,' 'tertibrachs,' etc. There passes along each arm, forking with it, an extension from each of the chief systems of the body; and to receive these the brachials are grooved on the ventral surface. We need only note here the axial nerve passing from the dorsal nerve-centre ('chambered organ') and innervating the arm-muscles; and the ciliated food-groove which sends a continuous current of water down

the arms and over the tegmen to the mouth. The axial nerve-cord is dorsal in position, *i.e.*, it lies at the very bottom of the ventral groove, and may be shut off from it by an ingrowth of stereom, so as to lie in a distant 'axial canal.' The food-groove lies on the ventral surface; it is fringed by extensions from the ambulacral or water-vascular system, and is protected by small plates that can shut down over it, and are called 'covering-plates' or 'ambulacrals.' The stem or column consists of a series of ossicles, which may be circular, pentagonal, stellate, or oval in section, but always are pierced by a central 'axial canal,' which contains a prolongation from each of the five chambers of the dorsal nerve-centre.

The modifications of this simple type are numerous and in very different directions. Some of them are extraordinary, and structures have been produced that long remained unsolved enigmas. Moreover, many modifications, both of ordinary and extraordinary type, can be shown to have occurred more than once in groups of very diverse origin; for instance, the work under review describes a Carboniferous Platycrinid, *Camptocrinus*, in which the stem has undergone the same remarkable curvature and arrangement of cirri as affected the Silurian Heterocrinid, *Herpetocrinus*. Were all the crinoids that ever lived placed before us, with no indication as to their distribution in time or space, it could only be by an unlikely chance that anyone would hit on their true relationships; and to the classification of one author, that of another could always be opposed. Fortunately we do know something of the succession of this remarkable series of forms, and we can trace, with some assurance of correctness, a few lines of descent which it would be hard to controvert. The whole history of the attempts to classify the Crinoidea, shows the gradual recognition of these principles, and the gradual emancipation from the older habit of lumping forms together because they were alike in structure without considering how the likeness arose. This has been the history of all branches of systematic zoology, and if the latest classification of the Crinoidea does not attain perfection, it is partly because there are still too many gaps in our knowledge of the geological history of the class, a point admirably emphasised by Messrs Wachsmuth and Springer, partly because it is one thing to have a conviction, and another thing to have the courage to act upon it, and by so acting to overturn established and accepted beliefs.

For the purpose of this article it is necessary to consider only those modifications of the simple crinoid type that influence the classification, in other words, those modifications which are believed to indicate some affinity between the forms exhibiting them.

In the simple type the arms are freely moveable on the radials, they are distinct from the cup, *i.e.*, do not help to enclose the viscera,

and are separate from one another, 'inadunate' as it is termed. Modification of this takes place in two directions, nearly but not quite the same, and both described as the incorporation of the lower or proximal brachials in the dorsal cup so as to support or surround the viscera.

In the one case this incorporation takes place by the intercalation of interbrachial pieces, and these and the 'fixed' or incorporated brachials are rigidly united by the firm mode of union known as 'close suture.' *Pari passu* with this incorporation of brachials in the cup there necessarily goes an incorporation of ambulacrals in the tegmen and their fixation by means of 'interambulacrals,' which are merely supplementary plates like the interbrachials. A further effect of this rigid fixing of the elements of the theca is that the ambulacrals of the tegmen cease to open, so that the food-grooves instead of being open gutters become closed tubes and pass beneath the orals to the underlying mouth. The process may even be carried further: the interambulacrals increase in size, and the ambulacrals may be squeezed down between them, so that all except a few of the larger ones are invisible from the upper surface of the tegmen; these larger ones become prominent and are called 'radial dome-plates.' Thus arises a form in which all the ambulacral structures, including the various extensions of the nervous, generative, and other systems of the body are absolutely subtegminal, and appear to be covered over by a rigid dome or vault of solid plates. So much is this the case that Wachsmuth, to whom the earliest complete account of the structure is due, supposed that the vault was actually a fresh formation that had somehow or other grown right across the normal ventral surface. That the vault is not really so anomalous a structure, but merely a modified tegmen, has only been proved within the last seven years by Wachsmuth and Springer, and is the view maintained in their present work.

In the second case incorporation of the lower brachials may be either by lateral union with those of adjacent rays, or by supplementary interbrachials, or by a finely plated integument; the difference is that the union is not rigid, but all plates above the radials retain some power of yielding or flexibility, even if they have not always the faculty of active motion. Of necessity correlated with the flexibility of the cup is the flexibility of the tegmen, which here gradually increases by decrease in size of the plates, or even by their complete disappearance; even the orals and ambulacrals have atrophied in some of the later representatives of this group. Another difference is the persistence of mouth and food-grooves as suprategminal, *i.e.* open on the ventral surface.

In accordance with these three types of structure it is possible to group the crinoids into three Orders. This is done by Wachsmuth

and Springer, who call the first Order Inadunata; the second, Camerata; and the third, Articulata. But were these the only characters to guide us, we should often err in referring families to their respective Orders; or, to put it another way, a collocation of families by these structures alone would bring together forms that other evidence forbids us to regard as related. We know for certain that we should place the Pentacrinidae and Antedonidae side by side, because this is just what has always been done. Fortunately Wachsmuth and Springer have discovered a fresh character, which they believe is of considerable value. They maintain that in all undoubted Inadunata and Camerata new columnals are developed next the cup, so that the top one is always one of the latest formed, and continually moves from its proximal position as new columnals develop; but that in all undoubted Articulata the top columnal is not the latest formed, but a persistent element, for which I propose to use the term 'proximale'; it often fuses with the infrabasals. This discovery is one of the chief novelties in the present monograph, and it appears to be of great importance. There is, however, no great attempt to prove its universal application; in fact the whole question is disposed of in the few following lines. "In the young Comatula [*i.e.*, *Antedon*], in which the top joint subsequently develops into a centrodorsal, in the recent [*sic*] Mesozoic *Millericrinus*, and probably in the recent *Rhizocrinus* and *Calamocrinus*, and in all Ichthyocrinidae, so far as observed, the new nodal joints were formed beneath the top joint, and the latter remained permanently attached to the calyx. In *Apiocrinus*, in which for some distance the upper end of the stem is greatly inflated, and the proximal joints extremely long, it is possible that the nodal joints were introduced below the inflated part, for there appear to be no immature segments between the upper joints." This last sentence is not quite correct. One often meets with a specimen of the Bradford pear-encrinite (*A. elegans*, Defr.) with imperfect ossicles in the proximal cone; indeed similar incomplete portions of columnals may occur above the proximale itself, as in the British Museum specimens registered 46,234 and 34,520. Whether these imperfect portions are immature, in the sense that they might have become more mature and complete, may be disputed, but they certainly resemble the columnals which Mr Alexander Agassiz has, no doubt rightly, regarded as immature in *Calamocrinus*. In such genera as *Ichthyocrinus* and *Taxocrinus* it is by no means easy to satisfy oneself that there is a persistent proximale. Of course when the top columnal fused with the infrabasals, it must have been persistent; but it did not always so fuse. I do not mean to say that there is any objection to this statement by Messrs Wachsmuth and Springer; but when it is introduced by them as one of the three "most important characters for dividing the Crinoids

into orders," one would have expected more direct evidence, more illustration, and more discussion of apparent difficulties, such as the abnormalities (for so I am content to regard them) met with in *Apiocrinus*, or the exactly opposite view maintained by some preceding writers concerning some of the genera mentioned.

Accepting the character as valid in the absence of actual disproof of its universality, we see that it enables a clear separation to be made between such a form as *Sagenocrinus* and certain Camerata, between *Pycnosaccus* and the Botryocrinidae, between *Millericrinus* and *Antedon* on the one hand, and the Pentacrinidae on the other. A proximale occurs in the former in each case, but not in the latter. But it does not follow from this that the presence of a proximale indicates genetic affinity. There can, it is true, be little doubt that all the Palaeozoic genera placed by Wachsmuth and Springer in their Order Articulata are allied; they can scarcely be separated even into genera. But it is by no means clear that they are the ancestors of the Neozoic genera placed in the same Order.

The Neozoic Articulata are distinguished from the Palaeozoic by the possession of 'pinnules,' which are defined by our authors as "small lateral appendages, given off alternately from opposite sides of the arms," to which should be added, that they have the same anatomical structure as arm-branches, but that they do not branch themselves, that their alternating arrangement is regular, and that when present the maturation of the generative products takes place only in them. I have long urged the view, in which I still firmly believe, that pinnules are derived from arm-branches, of which they are, "as happily expressed by Carpenter, repetitions on a small scale" (Wachsmuth and Springer). I am astounded to find that, in the opinion of the learned American writers, my "views respecting the pinnules are rather peculiar"; I fail to see any meaning in the argument that my "explanation is not satisfactory, as it would indicate that the smaller appendages are derived from the larger ones"; as for their belief that "every species of *Botryocrinus* [the genus on whose evolution I based my theory] has armlets, and that pinnules are not represented in any of them," I can only say that it can never be shared by anyone that has seen the type-specimen of *Botryocrinus pinnulatus*.

Our authors nowhere attempt to explain the origin of pinnules, so we are left to infer that they regard them either as independent developments, somewhat sudden in their first appearance, or as structures handed down from some Cystid ancestry. That they regard the possession of pinnules as a strong distinctive character, is shown by their further criticism of me on p. 161, where they say that I "cannot do" a great many things which I have done. When, therefore, they separate their so-called Articulata into the non-

pinnulate Impinnata and the pinnulate Pinnata, two sub-orders between which no connecting links are known, they force one to demand the evidence that the latter are not derived independently from pinnulate Inadunata. If they will not admit the origin of pinnules from armlets, it is hard to see how they can maintain the descent of Pinnata from Impinnata. It must be remembered that the only essential difference between the Pentacrinidae (the type of Johannes Müller's Articulata) and the Articulata Pinnata of Wachsmuth and Springer, lies in the possession of a proximale by the latter. Now, why can this not have been acquired just as easily as pinnules? It was acquired once, we may suppose, when the Impinnata originated; why not a second time, when the Pinnata separated off? This question has not been discussed by Wachsmuth and Springer, although necessitated by their opinions far more than by mine.

As for the name 'Articulata' our authors themselves recognise that it may be objected to on the ground that it does not correspond with the Articulata of Müller, and they propose the name 'Articulosa' as an alternative. That name, however, had already been used by Dr Jaekel in a different sense, in 1894, and the very appropriate name Flexibilia was proposed by Professor K. von Zittel in 1895. This last, being free from confusion with other names, is the best to adopt.

Let us turn now to the Order Inadunata. These "represent the simplest form, their dorsal cup being composed invariably of only two rings of plates, or three when infrabasals are present. It has no supplementary plates, except an anal piece; but this is not represented in all of them. The arms are free from the radials up." This order is divided according to the structure of the tegmen into two sub-orders: the Larviformia, in which the tegmen consists only of five orals, completely covering the mouth; and the Fistulata, in which the posterior inter-radius is "drawn out into a sac or tube." Long ago I criticised this division. Now, in the first place, I repeat that it does not hold good on mere morphological grounds; the anal tubes of *Symbathocrinus* and *Pisocrinus* are quite as highly developed as that of *Herpetocrinus*. The presence of a tube in the last-mentioned genus or in *Heterocrinus* is no more proof of the presence of interambulacrals in the tegmen than it is in *Pisocrinus*. But as I do not wish to plough barren fields of controversy, I leave this for the more important consideration that, even if our authors' statement of fact be granted, it appears to be admitted by them that the structure of the Larviformia represents a primitive stage, and that from them the Fistulata descended. Dr Jaekel has shown, for instance, that *Mycocrinus* and *Catillocrinus* are final stages in a series of which *Pisocrinus* and *Calycanthocrinus* are the earlier terms. The former are 'Fistulata,' the latter are 'Larviformia.' I have my-

self tried to prove the intimate relation existing between *Pisocrinidae*, *Heterocrinidae*, and *Calceocrinidae*. In short, the Larviform and Fistulate types represent grades of structure, and not those fundamental divergences, on which sub-orders should be based. In a paper on the Inadunata of Gotland I attempted to show that the presence or absence of infrabasals was a far more deep-seated character. So far as I can see the arguments now brought against this are—first, that I was wrong in saying that *Cupressocrinus* and *Myrtillocrinus* had no infrabasals (even though I said so with a note of interrogation); secondly, that I attached undue importance to another character, namely, the horizontal bisection of certain radials. Even if this were to be admitted, it could not substantiate the remark, "All this is seriously in the way of making the presence or absence of infrabasals a subordinal character." The question is, whether anyone has ever proved a transition from a true monocyclic form (without infrabasals) to a true dicyclic form (with infrabasals), or *vice versâ*. This question is partially discussed in another chapter by Messrs Wachsmuth and Springer, and the answer to it is "No." This is enough to place the character above the varying development of the tegmen.

In their sub-divisions of the Camerata our authors appear to me to be even less fortunate. I do not propose to discuss the validity of the families, merely that of the larger groups. And at the outset it must strike everyone as peculiar that the two chief divisions should be into a Typical and a Non-Typical section. Why should one section be more 'typical' than the other? The Typical section contains those forms in which the lower brachial and inter-brachials form an important part of the dorsal cup, and includes the Reteocrinidae, Thysanocrinidae, Rhodocrinidae, Melocrinidae, Calyptocrinidae, Batocrinidae, and Actinocrinidae. In the Non-Typical section brachials and inter-brachials are but slightly represented in the dorsal cup. The families are Platycrinidae, Hexacrinidae, Acrocrinidae, and Crotalocrinidae. It appears to me that we have to deal here with four quite different sets of crinoids, that have all undergone modification to a greater or less extent along Camerate lines, but that are of quite different origin. The Crotalocrinidae, for instance, I have always regarded as intimately connected with the Cyathocrinidae, although the publication of the proofs accumulated in favour of this view has been long delayed; here I am glad to be in agreement with Dr Jaekel. The Platycrinidae and their allies, as I have before this attempted to show, are not far removed from the Monocyclic Inadunata, and were developed independently, long after the rest of the Camerata had come into a flourishing existence. As for the latter, is it not reasonable to suppose that the monocyclic Melocrinidae, Calyptocrinidae, Batocrinidae, and Actinocrinidae, all which

have much in common, were derived from the monocyclic genera here referred to the Reteocrinidae, or at all events from simple forms like to them; and that the dicyclic Thysanocrinidae (or Dimerocrinidae), with their allies the Rhodocrinidae, were the descendants of the dicyclic Reteocrinidae? It does not seem at all necessary to lump monocyclic and dicyclic genera together in one family simply because their interbrachial plates are ill-defined.

Expressed in few words, an opinion as to the classification offered in this magnificent monograph might fairly say that from an anatomical standpoint it is by far the best that has yet been proposed, but that it serves as a key to structure rather than as an epitome of genetic affinity. The authors say: "We have not attempted to construct a genealogical tree for the Crinoids, or a branch of one for the Camerata, because such representations are generally unsatisfactory, and in this case the tree would have to be constructed too much upon imagination. Besides, our task is a humbler one. We have rather preferred to content ourselves in this respect with giving the general facts which our investigations seem to pretty well establish, and such interpretation of them as appears to us reasonably consistent therewith. Within these limits we have hoped that our generalisations may help to form a stable foundation upon which others may raise more ambitious structures." The absence of a phylogenetic tree is no cause for grumbling; but had the authors, when constructing their classification, kept phylogenetic principles more in view, they would probably have laid a foundation that would have needed less taking up and relaying by those who, in future times, shall complete the structure. Perhaps in the near future I may be allowed to indicate the plan that such a foundation might well follow.

There has been no attempt here to review the work as a whole, but while fault-finding may be postponed indefinitely, one can no longer delay an expression of gratitude for the large amount of information here collected and for the beautiful plates by Keyes, Westergren, Ridgeway, Liljevall, and others, that illustrate the work. Thanks also are due for the generosity of Mr Agassiz in producing these costly volumes as part of the *Memoirs* of the Museum of Comparative Zoology. But while expressing our thanks and our appreciation, we are repeatedly saddened by the thought that the senior author survived neither to receive the congratulations so justly his due, nor even to see this offspring of his maturity and full-garnered knowledge brought to the close that would have crowned his life's work.

F. A. BATHER.

SOME NEW BOOKS

After Darwin

Darwin and after Darwin. By the late George John Romanes. Vol. III. Post-Darwinian Questions: Isolation and Physiological Selection. Cr. 8vo, pp. 181. London: Longmans, Green & Co., 1897. Price, 10s. 6d.

The third and last volume of "Darwin and after Darwin" deals entirely with post-Darwinian questions, and is practically a re-statement in rather clearer terms of the views of the author and others on isolation and physiological selection. Clearness has not hitherto been a characteristic of the small school of writers represented by Romanes and Gulick, therefore a statement of their case in terms which could be "understanded of the people" was really desirable. We cannot think, however, that, having been so stated, it is likely to win over more supporters from the ranks of the natural selectionists. The more clearly the theory of physiological selection is formulated, the less adequate it appears to produce the results claimed for it. It is a very long way after Darwin indeed. That great master began with facts, and only after years of patient accumulation of these did he think himself justified in enunciating as general laws the conclusions he drew from their study.

Mr Romanes' theory scarcely even pretends to be founded on facts; it is based on predictions which have as yet only received even apparent verification in a very few cases, yet the author himself admits that "the whole theory" must "stand or fall with the experimental proof of the presence or the absence of cross-infertility between varieties of the same species growing on common areas." The few facts he does adduce "as serving to corroborate" his theory are scattered at wide intervals through the volume, and are drawn chiefly from (1) a group of allied plants in one locality, and (2) "several genera" of land mollusca.

When we say that, on the authority of Le Conte, even the Steinheim snails (*pace* Weismann!) are requisitioned to add to this category, it will be evident that the physiological selectionists have not been able to produce an overwhelming amount of evidence from direct observation. Meanwhile, cases "making directly against" the theory are quietly dismissed in a note (p. 135) as "not numerous."

The strength of the position taken up by natural selectionists lies in the fact that their theory of the adequacy of natural selection to produce divergence is based on the universally-admitted fact of individual variability, and starts directly from this point; they do not claim anything more as material to work upon. All other theories constantly require something to be taken for granted at the outset which is not universally admitted. No argument, however closely followed out to its logical conclusion, can be really convincing unless it starts originally from undisputed facts; the weak point of Romanes' book is that he is continually basing upon premisses which are, to say

the least, doubtful. Thus it is stated as a fact that hybrid plants are "rare in a state of nature." Botanists are by no means agreed on this point, and those who have made an exhaustive study of the flora of limited areas, with special reference to this question, tend more and more to the belief that hybridism is far from uncommon. On pp. 32 and 33, the whole argument is directed to showing that "we must henceforth cease to regard" natural selection "as in any instance the originating cause" of diversification in organic nature. Who could ever have begun to regard it as such? Individual variability is the originating cause, whether the "sustaining cause" be natural selection or physiological selection, or both, for it is admitted that they may act together.

Further, the method of argument is very imperfect. For example, geographical isolation is constantly referred to and used as an illustration of indiscriminate isolation, but it is not mentioned until the last chapter, and then only quite incidentally, that "it belongs to the very essence" of the author's view that "the efficiency of indiscriminate isolation as a 'vera causa' of organic evolution varies inversely with the number of individuals (*i.e.*, the size of the species-section) exposed to its influence." The reader, therefore, whose intelligence has enabled him to perceive that such a premiss was essential, has up to this point been obliged to set aside as valueless those statements from which it was omitted. This is a pity, but it may, of course, be partly due to the fragmentary nature of the book, of which only the first two chapters and the last were in type before the author's death, as the editor (Prof. Lloyd Morgan) explains in the preface. There are three appendices, which do not add materially to the value of the book. Altogether, we cannot think that "Darwin and after Darwin" strengthens its author's position with regard to his theory; the latter must still be regarded as not proven, though future evidence may modify this opinion. At present it cannot be said that good cause is shown for considering physiological selection as of paramount importance as a factor in evolution, or that the theory gains much by this exposition.

The Freshwater Fauna of Bohemia

Untersuchungen über die Fauna der Gewässer Böhmens. By Anton Fritsch and V. Vávra. Prag.: Fr. Rivnac, 1897.

Drs Anton Fritsch and V. Vávra have issued Part III. of their joint researches on the fresh-water fauna of Bohemia; this section deals with the animals inhabiting the lakes known as the Schwarzer See and the Teufelssee, as well as with the land-fauna and flora of the neighbourhood of each. Their results are evidence of the excellent work that may be done, without any very large outlay of money, by setting up temporary portable zoological stations in little-worked localities, and making thus a thorough study of the fauna of a limited area. Marine biological laboratories have already more than justified their existence in England and other countries, and we should like to see many more inland stations of the kind which Bohemian enterprise has made so successful. Especially is one needed in our own country, but nobody seems inclined to go to work. During four years' work in the neighbourhood of the lakes the investigations were very exact

and exhaustive, and fresh-water fauna were for the first time studied with reference to their bathymetrical distribution. Full lists were made of all species observed; these might have been more numerous in a more fertile region, but the methods of investigation leave nothing to be desired.

The ingenious but simple apparatus (figured on page 15 of the publication) for catching small land-animals of various kinds is worthy of special attention, and might be used by anyone living in the country, with the result of greatly increasing our knowledge of the species inhabiting one district. A general summary of results would have added to the interest of the pamphlet, which consists of 74 pages, and is profusely illustrated.

Indo-Pacific Shells

Catalogue of the Hadfield Collection of Shells from the Loyalty Islands. By J. C. Melvill and R. Standon. Parts II. and III. 1897. Price 2s.

This pamphlet forms part of the series of handbooks issued by the Manchester Museum. Part I. was published in 1895, and the whole is merely a reprint from Vol. VIII. of the *Journal of Conchology*. The list will prove useful to future workers, not only on the fauna of the Loyalty Islands, but also of other localities in the Indo-Pacific. Many of the species have a wide range, and the authors call attention to "the cognate character in the molluscan fauna" of those islands and the Mauritius. That of the Loyalty Islands appears to be extremely rich, as many as 860 species being recorded by Messrs Melvill and Standon. Nearly all of the 106 new species described are very small, but many of them are very beautifully sculptured. It is questionable whether the authors are to be commended in such free use of Greek for the specific names. Mr Hoyle's introduction states that a few of the type specimens remain in Mr Melvill's cabinet, but the final paragraph of the paper says, "The original types are all in the Manchester Museum."

Life

What is Life? or, Where are We? What are We? Whence do we Come? and Whither do we Go? By Frederick Hovenden, F.L.S., F.G.S., &c. London: Chapman & Hall, 1897.

The legs and feet of this work are physical, and developed in accordance with principles which modern physicists (who are severely handled) regard as likely to render them weak-kneed and rickety. Its head and shoulders rise into regions of anti-theology. Its middle (concerning which alone we are here concerned) is mainly a piece of biological patchwork, to form which scraps from many authors have been collected with more diligence than discrimination. Apart from the patches, we have not discovered anything of biological value in the work. Here is a sample of the conclusions to which the author is led. "All living creatures, except the very lowest forms, are built up of cells and the secretions of these cells. All cells are built up of molecules. In the higher animals, including man, the cells are controlled by the central molecule, which is in its turn controlled by the fundamental atom." At death the constituents of the body tend to be distributed in the air. "From principally the air, the specific

atom, which forms the initial fundamental molecule, again gets into the system of the human female, gathers to itself from the living organism the material to form the fundamental molecule, which is the initial formative power of the growing object—the human egg. And this egg, by the process already described, alters itself by adding to itself the material from the parent organism and forms the human being." Here we have a philosophy of generation and regeneration in a nut-shell.

Down with Natural Selection!

The Argument of Adaptation; or, Natural Theology Reconsidered. By Rev. George Henslow, M.A., F.L.S., &c. London: George Stoneman, 1897.

Apart from the arguments with regard to Natural Theology, the discussion of which may be left to others, this little volume sets forth the contention that natural selection is an "hypothesis based on an imaginary but baseless inference." Artificial and natural selection are not parallel processes, but diametrically opposite in character. "Not a trace of the innumerable unfavourable variations have [*sic*] ever been seen, whether in a plant or an animal." There, is, however, no adequate discussion of the evidence for variation under nature. And the assertions with regard to biological questions are so subservient to the main theological purpose of the work that it must suffice to state that these opinions among others are to be found in Mr Henslow's booklet.

Indian Agriculture

The Foundations of Scientific Agriculture. By Samuel Cooke, M.A., &c., Principal of the College of Science, Poona. 8vo, pp. ix. 268. London: Longmans, Green & Co., 1897.

Agriculture is unquestionably the greatest and most important of all industries, the progress of which has been continually hampered by ignorance of the theory by practical workers. Scientific systems, when applied by rule of thumb, have only too often led to disaster owing to reckless waste of expensive materials and the lack of adaptation to local conditions. Hence every work which spreads a knowledge of scientific principles upon which some of the improved methods of farming have been founded, is to be welcomed. A considerable number of small text-books on elementary agriculture have appeared during the past few years. Prof. Cooke's work will rank among the best. It is especially intended for use in India, but may be read with advantage by English students owing to the freshness of the example quoted. The book is based on a series of lectures delivered to classes working at agriculture and forestry at the Poona College of Science. It consists of fourteen chapters. The first three contain the general introduction and the meteorological part of the subject. The soil is described in four chapters in which are explained the necessary facts of geology, mineralogy, crystallography, and chemistry. Then follows a chapter on the elementary facts of botany, and three with crops, manures, and on the agriculturalist himself. Finally comes a chapter on mensuration, a glossary, a list of examination questions, and three appendices.

The work deals with the elements of so many sciences that a few errors are inevitable. Thus in the table of British strata the coral marbles are

assigned to the Lower instead of to the Middle Devonian; Silurian limes and fluxes are said to come from the Ludlow beds and only green slates from the Wenlock series. On page 3 we read of the *Pax Britannicae*. But slips like these do not materially lessen the value of the work which ought to have a wide circulation among Indian schools.

An American Astronomy

A New Astronomy. By David P. Todd, M.A., Ph.D. 8vo, pp. 480. With 6 coloured plates. New York, Cincinnati, Chicago: American Book Company. 1898. Price, $1.30.

We regret that the fascinating science of astronomy does not come within our scope, otherwise it would have given us great pleasure to have reviewed this elegantly illustrated little book, especially as the writing of the review would have given us very little trouble, for the publishers, with a business-like courtesy, have been at the pains to forward us both a short notice and a longer account in pamphlet form, both of which they would kindly permit us to reprint without acknowledgment or extra charge. We must content ourselves with drawing the attention of astronomically-inclined readers to the book.

Serials

Knowledge, for April, contains three very interesting articles. Prof. Grenville A. J. Cole writes on the Structure of Ireland, considering it from a broad standpoint as part of Europe. Mr R. Lydekker discusses the Sea-Otter and its extermination, giving a figure of its upper and lower jaws from a skull collected by Mr Barrett Hamilton. Mr Fred. Enock continues his paper on British Bees. Mr Enock's illustrations should be known to all; his text is equally clear and interesting.

In Vol. VI. of the *Studies from the Yale Psychological Laboratory* (1896), edited by Dr E. W. Scripture, there are researches on reaction-time, on Weber's law in illusions, and on voluntary effort. Perhaps the most generally interesting paper is that by the editor, in which he describes an elementary course in psychological measurements. This gives a good idea of the kind of laboratory work which is carried out at Yale under Dr Scripture's direction.

A short time ago we announced that *Timehri*, the Journal of the Royal Agricultural and Commercial Society of British Guiana, would cease publication in December last. On receipt of the December number we were pleasurably surprised to find that the magazine would be continued, with a reduced number of pages, at a price of 60 cents. (2s. 6d.) a copy. Somewhat appropriately, but we hope not ominously, the present number contains an instructive and amusing article entitled "Abortive Colonial Publications," by the Editor, Mr James Rodway. Mr J. J. Quelch writes on Boa Constrictors (Camoodies as they are called in British Guiana), while Mr C. A. Lloyd contributes notes on some Neotropical Birds.

In the February *Pearson's Magazine* the growing appetite of the public for popular natural history is met by an account of the trout-farm at Guildford. This is interesting reading, and, from our point of view, is more free from scientific errors than is usually the case in

articles of this description. The illustrated development of the trout is pedantically described as its 'evolution,' and its yolk-sac is inaccurately placed. A two-year-old trout, we are told, passed an accidental sojourn in a 'fry-pond' for a few months, and lived up to his privileges to the extent of devouring 30,000 fry. Those who are prepared to accept this statement will, we do not hesitate to state, cry 'enough' when told that the weight of this 'two-year-old' increased during that period from 6 oz. to 5¾ lbs. The article is beautifully illustrated, and cannot fail to interest. We cannot say the same of the extraordinary literary effort on "Human Nails and Horns," preceding it. Here the author audaciously describes everything from a human wart to a deer's antler as a 'horn,' apparently considering that the authority of the *Boston Medical Journal* and the like is sufficient to allow his artist to give free vent to his imagination. He remarks: "The whole subject is one highly deserving of attention from the naturalist or the philosopher." Speaking from the point of view of the former, we think we may safely pass this article on to the latter!

We continue to receive copies of interesting papers from Mr T. H. Holland, now officiating Superintendent of the Geological Survey of India. The latest is "On a Quartz-Barytes rock occurring in the Salem district, Madras Presidency" (*Records Geol. Surv., India*, vol. xxx. pp. 234-242, pl. xviii., 1897). The rock forms a network of veins in gneissic rocks. The veins, which vary considerably in size, occupy fissures inclined at all angles to the horizon, and are composed of quartz and barytes in the proportion of 7 to 3. In the rock there are also found small quantities of accessory minerals, such as galena, pyrites, ilmenite, and hematite, which carry a small proportion of gold, 13 grains to the ton. The barytes is well crystallised, often forming large individuals, and this, as the author points out, is also the case even in veins of the smallest dimensions. The quartz is seen under the microscope to consist of an aggregate of irregularly interlocking crystals, which are sometimes quite microscopic. The author's conclusion is that both the quartz and barytes are original constituents, which have separated out from an injected mobile magma, the barytes being the first to crystallise. He rejects another possible explanation, namely, the derivation of the rock from a pegmatite (barytes replacing felspar by pseudomorphism), on the ground that the proportion of quartz to felspar in the graphic pegmatites is quite different; moreover, there are no traces of any material after which the barytes might be pseudomorphous.

The John Hopkins University *Circular* for November 1897, is melancholy reading, for in it Prof. W. K. Brooks has to tell the story of the students' expedition to Jamaica in the summer of 1897, and its tragical end. A party had been formed, under the charge of Prof. J. E. Humphrey, for the purpose of botanical and geological research, and they set up a temporary laboratory at Port Antonio. Here two months' good work was done, and Prof. Humphrey, with Drs Conant and Clark, and Mr Fredholm, had seen all the younger members of the party safely started for home, when the former was suddenly struck down by fever, and died on August 17th, after a few

hours' illness. Dr Conant, left in charge, unselfishly refused to hasten his own departure and leave his friends behind; both he and Dr Clark were taken ill, and Dr Conant died on his way home. This number of the *Circular* is especially devoted to memorial sketches of Prof. Humphrey and Dr Conant, whose untimely deaths have caused an irreparable loss, not only to the biological department of the University, but to all who ever came in contact with these earnest and single-minded workers. The *Circular* also contains short papers by Conant, Clark, and others, on the viviparous *Synapta* of the West Indies, the follicle-cells in Salpa, the Cubomedusae, and other subjects.

Mr W. E. Hoyle has sent us a supplement to his "Catalogue of Recent Cephalopoda," including the 79 new species published between 1887-1896. Most of the novelties are from eastern seas, and are due to Drs Ortmann and Brock, and Mr E. S. Goodrich; but the most important systematic work of recent years is Dr Jatta's Monograph on the Cephalopoda of the Gulf of Naples, which was reviewed by Mr Hoyle in our own pages. Mr Hoyle, who of course writes as an authority, states that he has found scarcely any omissions from the lists given in the *Zoological Record*. This supplement, as was the original catalogue, is published by the Royal Physical Society of Edinburgh; the date 1897 is printed on the wrapper, and we learn that it is a reprint from the *Proceedings* (pp. 363-375); but we do not gather from the pamphlet before us what was the volume in which it originally appeared, or whether it is to be purchased in its separate form, and if so at what price. We mention these points merely because we were given to understand a short while since that the Royal Physical Society of Edinburgh was initiating some useful reforms in connection with authors' reprints.

Further Literature Received

Biomechanik erschlossen aus dem Organogenèse, Mehnert: Fischer, Jena. Fossil Plants for Students, Seward: Cambridge University. Text-book of Botany, Strasburger and others, translated by Porter; Essays on Museums, Flower; Notes on Observations, Lupton: Macmillan, London. Mammals, Reptiles and Fishes of Essex, Laver: Essex Field Club. Practical Radiography, Isenthal and Ward: Dawbarn & Ward, London. Elementary Chemistry, Cheetham: Blackie, London. Anatomie Comparée, Roule: Masson, Paris.

Results of Swedish Research into Grain Rust, Eriksson: *Botan. Gaz.* Resultate der Tiefsee-forschung, Chun. Ratzel's History of Mankind, 24, 25: Macmillan. Princetown Contributions to Psychology, vol. ii. No. 3. 20th Rep. State Entomologist Illinois. Bergens Museums Aarbog, 1898. Witwatersrand Banket, Goldfields of S. Alaska, Becker: *Ann. Rep. U.S. Geol. Survey.* Kant as Natural Philosopher, Fractional Crystallisation of Rocks, Becker: *Amer. Journ. Sci.* Contents-Subject-Index to General and Periodical Literature, sections 3-6, Cotgreave. Ann. Rep. Raffles Museum, Singapore, 1897. Castration nutriciale chez Hyménoptères, Marchal: *C.R. Soc. Biol.* Entomologie appliquée en Europe, Marchal: *Bull. Soc. Nat. Acclimatation.* Cécidomyies des Céréales, Marchal: *Ann. Soc. Entom. France.* Univ. Wisconsin Agric. Expt. Station, Bull. 65. Existe-t-il une force vitale? Errera. Atoll of Funafuti, pt. 6: *Mem. Austral. Mus.* U.S. Dept. Agriculture Circulars, 2nd series, Nos. 22-28.

Scot. Geogr. Mag., April; Amer. Journ. Sci., April; Amer. Micros. Journ., March; Amer. Nat., Feb.; Victorian Nat., Feb.; L'Anthropologie, Jan. and Feb.; Botan. Gazette, Mar.; Feuille des Jeunes Nat., April and May; Irish Nat., April; Westminster Rev., April; Knowledge, April; Literary Digest, Mar. 12, 19, 26, April 2; Naturae Novit., Feb., No. 4; Scot. Med. and Surg. Journ., April; Naturalist, April; Nature, Mar. 17, 24, 31, April 7; Nature Notes, April; Naturen, Mar.; Photogram, April; Proc. Biol. Soc. Washington, xii. pp. 31-84, Mar. 24; Psychol. Rev., Mar.; Review of Reviews, Feb., Mar.; Revue Scient., Mar. 19, 26, April 2, 9; Science, Mar. 11, 18, 25, April 1; Scientific Amer., Mar. 12, 19, 26, April 2; Journ. School. Geogr., Feb., March; Riv. Psichologia, 22; Timehri, x. part 2.

OBITUARIES

JOHN ROBERT STREATHAM HUNTER-SELKIRK, who died on March 23, in the sixty-third year of his age, at his residence, Daleville House, Braidwood, near Carluke, Lanarkshire, was a well-known antiquary and geologist. From his rich collections he had made large donations to the Museums of Kilmarnock and Airdrie, and he also bequeathed some to different Institutions. For many years he had been a member of the Royal Physical Society of Edinburgh, and of the Geological Societies of Edinburgh and Glasgow.

FRANZ FIALA, Curator of the pre-historic and anthropological department of the National Museum of Bosnia-Herzegovina, died at Sarajevo on January 28, 1898, aged 36 years. He had published much on the flora of those countries and had also made numerous studies in their archaeology, especially on the pre-historic tumuli of Glasinatz in connection with Dr C. Truhelka.

GEORGE CHRISTOPHER DENNIS, for many years President of the York and District Field Naturalists' Society, died suddenly of apoplexy at York on December 22, 1897.

The deaths are also announced of:—JULES MIGNEAUX, a well-known natural history draughtsman, at Billancourt, aged 65; P. B. L. VERLOT, the botanist, at Verrières-les-Brusson; E. J. S. LINNARSSON, the botanist, a tutor in Sköfde, Sweden; RAMON LISTA, the well-known Argentine naturalist and explorer, whose death occurred towards the end of last year in the forest near Mira Flores in the Gràn Chaco; Dr A. ZIMMETER, Professor of Botany at Innsbruck, aged 49; A. J. HORACE PELLETIER, at Madon, France, in 1897, a lawyer who worked on noxious insects; JOSÉ D'ANCHIETÁ, who had made zoological collections and observations in the African possessions of Portugal, at Caconda in Angola, on September 14, aged 66; EMMANUEL MARTIN, lepidopterist, at Creil, France, in 1897; J. HOYES PANTON, Professor of Natural History at the Ontario School of Agriculture and a writer on fossil mammals, on March 2; at New York on November 21, aged 54, General ALBERT ORDWAY, who had written on the Crustacea, especially the genus *Callinectes;* the metallurgist, Prof. KNUD STYFFE, aged 74, for twenty-five years director of the Stockholm Technical College; Dr K. B. JACOB FORSSELL, the lichenologist, at Karlstad, Sweden, on February 11; Prof. KIRK, author of the "Forest Flora of New Zealand," and of other monographs upon the trees of those islands; ALPHONSE BRIART, the well-known Belgian geologist, on March 15, aged 73.

NEWS

THE following are among recent appointments: — Henry Hanna, to be demonstrator in biology, geology, palaeontology, of the Royal College of Science, Dublin; Dr H. W. M. Tims, to be professor of zoology at Bedford College for Women, London; Dr Hanson Kelly Corning, as professor of anatomy at Basle University; Dr Gräfin Maria Linden, as second assistant in zoology at Tubingen University; Dr Paul Schiemenz, as director of the Biological and Fish-Culture Station at Müggelsee; Dr Johannes Thiele, of Strasburg, will succeed him at Berlin as assistant in the Zoological Department of the High School for Forestry; H. C. Bumpus, of Brown University, to be scientific director of Wood's Holl Station, U.S.A.; Dr Charles R. Barnes, of Wisconsin University, to be professor of plant physiology in the University of Chicago; Madame Lemaire, to be professor of drawing applied to plant study, at the Muséum d'Histoire Naturelle at Paris; Surgeon-Major David Prain, to be superintendent of the Royal Botanical Gardens, Calcutta, in succession to George King, retired; Dr Eugenis Serra, as assistant in the Botanical Gardens of Palermo; Professor Arthur Borntraeger, of the School of Agriculture at Portici, to be director of the Agrarian Station in Palermo; Dr H. F. Harris, as professor of bacteriology at Jefferson College; Dr J. L. C. Schroeder van der Kolk, as professor of mineralogy in Delft Polytechnic; Emil Wiechert succeeds in part the late Professor E. Schering at Göttingen University; the professorship of astronomy is now distinct from geophysics and earth magnetism, the section presided over by Dr Wiechert; L. V. Pirsson, to be professor of physical geology at Yale University, and not at Harvard, as stated in our April number.

THE Seventh International Congress of Geography is to be held at Berlin in 1899.

THE Museum of Bonn University has received the anthropological collection of Schaffhausen.

THE University of St Andrews intends to establish a professorship in Physiology, and in Anthropology and Anatomy.

PROF. G. B. HOWES has received the degree of LL.D. *honoris causa*, and Mr A. T. Masterman that of D.Sc., from the University of St Andrews.

THE collection of mammals made by the late Dr Harrison Allen was bequeathed by him to the Academy of Natural Sciences of Philadelphia.

DR HUGO BÜCKING and Dr L. van Werveke have started for an eight months' expedition to the Netherland East Indies on behalf of a Dutch Society.

WE regret to learn that La Fayette College had a large part of its scientific equipment and all of the herbarium destroyed by fire on December 18th.

THE Eighth Annual Meeting of the German Zoological Society is to be held at Heidelberg, June 1st to 3rd, under the presidency of Prof. F. E. Schulze.

WE are glad to learn that Mr W. P. Pycraft has been elected an Associate of the Linnaean Society. Mr Pycraft has been busy of late in the preparation of a key to the osteology of birds.

THE Swedish Anthropological and Geographical Society has awarded the Vega Stipend to Mr J. Stadling, who has started on a journey through Siberia in search of possible traces of Andrée's balloon expedition.

Mr Edouard Foa has travelled across Africa by the basin of the Zambesi, Lake Tanganyika, and the Congo, and has brought back numerous specimens of anthropological interest from the region of the great lakes.

Dr S. Schönland, the Director of the Albany Museum, Grahamstown, left on March 18th for a three or four months' trip to Europe. His address will be :— Per Adr. Herrn Schönland, Frankenhausen (Kyffh.), Germany.

The ss. 'Belgica' with the Belgium Antarctic Expedition has grounded among the group of islands near Cape Horn, in consequence of which Lieut. Gerlache will not proceed further than the Shetland Isles in the Antarctic this year.

Magdalen College, Oxford, announces that a fellowship in medical science will be given by the college next October. There will be an examination in sciences relating to medicine, and original writings may be submitted by candidates.

Dr Otto Nordenskiöld and Dr Gunnar Andersson, of Stockholm University, with four scientific assistants, left Sweden at the end of March for Klondike, intending to be away about two years, and to make a thorough scientific exploration of the country.

Dr Kishinouye, the representative of Japan at the Bergen Fisheries Exhibition, reached London in March from the United States. He has installed the Japanese exhibit at Bergen, and has returned to work at the Natural History Museum, London.

Mr Krupp of Essen has given 10,000 marks to the Berlin Geographical Society for a gold medal to be awarded yearly for geographical discovery. It is to be called after Gustave Nachtigall, the African explorer, and preference will be given to discoveries on the African continent.

In recognition of the services rendered to the Zoological Society of Dublin by the late Dr Samuel Haughton it is proposed to erect a memorial building in the gardens of the Society. Subscriptions for this purpose may be sent to Prof. D. J. Cunningham, Hon. Sec. to the Royal Society, Dublin.

With reference to the resignation of Dr R. Semon, already announced by us, the *American Naturalist* remarks : "The monotremes and *Ceratodus* seem veritable 'hoodoos.' The material obtained a dozen years ago by Mr Caldwell, aided by Royal Society funds, is lying unused, and with no prospect of being studied."

Among forthcoming arrangements at the Royal Institution, we notice that on May 6th Mr E. A. Minchin is to lecture at nine o'clock on "Living Crystals," which those who know Mr Minchin's admirable work will readily interpret as the growth of sponges. On May 21st and 28th, at 3 p.m., Mr J. Arthur Thomson will lecture on "The Biology of Spring."

Prof. Grimeaux, of the *École Polytechnique*, Paris, has been deprived of his post for having given evidence at the trial of Zola ; and Dr R. H. Warren, State Zoologist of Pennsylvania, has resigned because his political opinions differ from those of Governor Hastings. Democratic Government does not appear to be favourable to the scientific attitude of mind.

The following are announced as Presidents of Sections at the forthcoming meeting of the British Association :—Physics, Prof. W. E. Ayrton ; Chemistry, Prof. F. R. Japp ; Geology, Mr W. H. Huddleston ; Biology, Prof. W. F. R. Weldon ; Economics, Dr J. Bonar ; Mechanics, Sir John Wolfe-Barry ; Anthropology, E. W. Brabrook ; Botany, Prof. F. O. Bower.

The Museum of Nantes has received the addition of a hall sixty metres long. Dr L. Bureau is attempting to display as complete a representation as possible of the fauna, flora, and geology of the West of France. In this attempt, says *La Feuille des Jeunes Naturalistes*, the richness of his collections renders success more than probable.

We also learn from *La Feuille* that Mr Lennier, Director of the Havre Museum, intends to exhibit in the galleries of the second storey, which have recently been furnished, the ethnographical collections made by D'Entrecasteaux, to which he will add numerous specimens of similar character already possessed by the museum. He is only waiting for money enough to buy glass cases.

The City of New York undertook to provide the New York Zoological Society with a site for a zoological garden on the condition that the Society raised the sum of $250,000 for buildings and collections, of which sum $100,000 had to be obtained before the 24th of March last. This sum having been obtained, chiefly by means of large subscriptions from millionaires of the city, the Society can now take possession of the site.

We learn from *Science* that Prof. Nils E. Hansen, Professor of Horticulture at Brookings, South Dakota, who was despatched by Secretary Wilson of the Agricultural Department of the United States, to secure new, rare, and valuable seeds, has returned from a journey through Eastern Russia, Trans-Caucasia, Russian Turkestan, Western China, and Siberia, having obtained about three carloads of seeds, which will be distributed to State experiment stations and others, chiefly for use in the arid regions.

The following lectures, with lantern illustrations, are being delivered in the Whitechapel Museum :—On Tuesday, April 12th, at 8 P.M., "The Horse and Dog and their Relations and Friends," by Prof. Hobday; Tuesday, May 10th, at 8 P.M., "Butterflies," by Prof. W. F. R. Welldon; on Tuesday, June 7th, at 8 P.M., "A Piece of Wood," by Prof. Marshall Ward. Admission free by ticket, to be obtained in the Museum and Lending Library. The Museum is open to the public daily from 3 P.M. to 10 P.M., Sundays included, and on Saturdays from 10 A.M. to 10 P.M.

There has for some time been forming in New York what is termed a Scientific Alliance, that is to say a union of various scientific societies in the city, for various purposes, the chief of which is the erection of a building in which their meetings can be held. A design prepared by R. W. Gibson is published in *Science* for March 25, and an appeal is made to the public-spirited citizens of New York for financial support. Another way of promoting this excellent object was a dinner held at the Hotel Savoy, on March 16, with Mr C. F. Cox, President of the Council of the Alliance, in the chair.

The following have been appointed on a Select Committee of the House of Commons to enquire into and report upon the administration and cost of the Museums of the Science and Art Department :—Lord Balcarres, Mr Bartley, Sir Mancherjee Bhownaggree, Mr John Burns, Mr Daly, Dr Farquharson, Sir John Gorst, Mr Ernest Gray, Sir Henry Howorth, Mr Humphreys-Owen, Mr Kendrick, Mr Platt-Higgins, Sir Francis Powell, Mr Woodall, and Mr Yoxall. The deliberations of this Committee's predecessor have had some effect, for the Government intends at last to complete the buildings at South Kensington, and are asking for that purpose a sum of £800,000.

We learn from *Nature Notes* that under the title of Audubon Societies there have been formed in the United States no less than fourteen bodies, the main purpose of which is to discourage buying and wearing for ornamental purposes the feathers of any wild bird. The Massachusetts States Legislature has passed a bill prohibiting the wearing of song and insectivorous birds on women's hats, and the law is being vigorously enforced in the city of Boston. An official of the Boston Natural History Society Museum has published a list of no less than forty species of birds which he saw stuck on women's heads. The latest victim of fashion is said by the same official to be the grebe. The great crested grebe

and the little grebe have been called the greatest ornithological ornaments of our inland waters. After this we suppose those waters will miss their ornaments. Andrée Goddard, writing in the *Revue Scientifique*, says, "It is high time, if not indeed too late, to add to the precepts of the Bible and the Koran, and to substitute for the poetic legends that have hitherto prohibited massacre, a scientific and social organisation for the preservation of bird species."

We learn from the *Scientific American* that a rival to Klondike has arisen in the village of Hadley, Warren County, New York. This is the centre of a district in which a large amount of gold is believed to occur. It is found in a fine state adherent to grains of sand. At some places the sand is found at a depth of 25 feet, and at other points still deeper. The gold is separated by the quicksilver process after the sand has been pulverised, and it is believed that the yield will be equal to $4 for each ton passed through the crusher. It is intended also to try a process called the combination cyanide-chlorination method. More than one company has been started, and claims have been made by thousands of prosecutors. It is also stated that there has been formed in the United States an Electrolytic Marine Salts Company for the purpose of extracting gold and silver from sea-water. It has of course been known for some years that those metals occur in minute quantities in the sea, but it has been supposed that they could not repay the labour necessary for extracting them. It is said that a large number of electrolytic apparatus are already in operation and that each obtains gold to the extent of £24 a day.

Prof. Seeley's Geological Field Class has arranged this year for a series of excursions, especially to illustrate the physical geography and geology of the Thames Basin. This is the thirteenth year of the Society's existence, and its continued growth testifies greatly to the interest aroused in the subject by the method of study adopted. The London area is not a particularly good centre for class field work, in spite of the extreme interest of its geological history. The absence of volcanic and plutonic rocks, and of any deposits earlier than the Middle Mesozoic, puts one serious limitation, and the great width of the suburban belt renders excursions lengthy and costly. It is, therefore, all the more pleasing to find that Prof. Seeley's Field Class continues such vigorous life, for it no doubt means that during successive years a large number of students have profited by the course of studies. This year's subject will be illustrated by excursions along a line from the Upper Jurassic rocks of Aylesbury, across the Chiltern Chalk hills, over the Cainozoic deposits of the Thames synclinal to the North Downs, and finally to the Wealden beds around Cuckfield. The honorary secretary of the Society is Mr R. H. Bentley, of 43 Gloucester Road, South Hornsey, N.

At the Annual Meeting of the Norfolk and Norwich Naturalists' Society, held on March 29, Mr T. H. Gurney was elected president. The retiring president, Mr Arthur W. Preston, delivered an address, in the course of which he dealt with the weather of the past ten years, and its effect upon the leafing and blossoming of trees and plants. He handed round some carefully prepared tables showing the main features of the temperature and rainfall, the direction of the wind, and the dates of first leafing of trees, and first flowering of plants, both garden and indigenous, during the period. These illustrated the marked effect that temperature had on the development of vegetable life. In 1888, when the mean temperature of every month, from January to August inclusive, was below the average, the greatest number of latest dates of first flowering were recorded up to the conclusion of harvest, and the same occurred in 1891, though in a less marked degree. On the other hand, in 1893, when every month from February to August was above its average temperature, a large majority of the earliest phenological dates were recorded. In other years, when certain months

were marked by extremes of temperature, but were followed by months of an opposite character, there was not much departure from the average of the dates of first flowering.

On June 2nd, 3rd, and 4th, the third Annual Congress of the South-Eastern Union of Scientific Societies will be held in the Town Hall, Croydon. On Thursday night, June 2nd, Prof. G. S. Boulger will give the Presidential Address. The following papers will be read and discussed :—"Entomology as a Scientific Pursuit," by J. W. Tutt; "Ancient and Modern Dene Holes and their Makers," and "Natural Gas in Sussex," by C. Dawson; "Photography in Relation to Science, with Lantern Illustrations," by J. H. Baldock; "The Place of Geology in Education," by Prof. J. Logan Lobley; "The Soil in connection with the distribution of Plants and Animals," by H. Franklin Parsons; "Life History of the Tiger Beetle, with Lantern Illustrations," by Fred. Enock; "New Methods of preparing Fossils, with Demonstrations," by Dr A. W. Rowe; "Ideals for Natural History Societies, and how to attain them," by J. M. Hobson; "Botanical Work still wanting Workers," by E. M. Holmes. There will be a conversazione on Friday evening. A meeting of delegates from affiliated societies will be held on Saturday at 10.30. Tickets (admittting to all meetings): Members of affiliated societies, 2s. 6d. each; persons unattached, 3s. 6d. each. Applications for these should be made to the Hon. Gen. Sec., Dr G. Abbott, 33 Upper Grosvenor Road, Tunbridge Wells; C. Poulett Harris, Hon. Sec. of Local Committee; and R. F. Grundy, Hon. Sec. of Croydon M. & N. H. Club.

The Lincolnshire Science Society, which has been the subject of so much correspondence in various papers, puts forward the following objects of study for its members during the ensuing year :—Geologists are asked to limit their attention to the Glacial Beds that occur in those portions of the Trent and Witham Valleys that lie within a ten-mile radius of Lincoln. The most important problems connected with these are the determination of their age by their topographical position, the collection of the mammalian and other remains that occasionally occur, and the recording of the erratic boulders of the district. Botanists should devote special attention to the careful recording of the Algae and Fungi found within ten miles of the city of Lincoln. The mounting of permanent specimens of the most uncommon species is essential. A list of flowering plants found within the same radius, arranged according to their natural orders, with the time when found in flower, and the exact locality, is also a desideratum. Notes on the insects found visiting the flowers would also be useful in forming a county record. The meteorologists are to study the rainfall of Lincolnshire in connection with mortality tables. Zoologists are requested to direct attention to the breeding localities of the more uncommon birds of the county. Special attention should be directed to the immediate neighbourhood of Lincoln. An investigation of the plant seeds, insects, &c., found in the stomachs of birds would be of great value from an economic point of view. Members will find some interesting information bearing on this point in some papers recently published by the Board of Agriculture. Entomologists who, it is interesting to notice, are carefully separated from zoologists, are expected to verify all records of Lepidoptera in the separate divisions of the county. The photographers may make a photographic survey of the City of Lincoln, especially of features likely to be swept away in the course of street improvements. A programme of many interesting excursions to be undertaken during the summer has been sent to us.

CORRESPONDENCE

THE BRITISH MUSEUM CATALOGUE OF MOTHS

I HAVE read, in common with doubtless most lepidopterists, the circular relating to the publication of a series of volumes on the Lepidoptera Phalaenae with interest, in my case heightened by the fact that types of more than five hundred species described by myself are contained in the British Museum collection. It is owing to this interest, felt in the success of the undertaking, that I wish to protest against the resolution expressed in paragraph 10 of the circular, that the classification will follow that adopted by Mr E. Meyrick in his recent work on British Lepidoptera. May I suggest at once, that in a work like that proposed, a wise conservatism in the choice of the arrangement of the material will best subserve its purposes? In the present instance the choice of Mr Meyrick's classification is peculiarly unfortunate, since this rests upon speculations which the results of recent research stamp as improbabilities. From Mr Meyrick's work it appears certain that (1) it does not afford a working theory as to the evolutionary changes of the neuration upon which the classification is nevertheless apparently based, while Mr Meyrick fails to give sufficient or reasonable proof for the probability of his sequences, and also (2) that the figures of neuration with which Mr Meyrick's writings are interspersed are quite inaccurate and misleading so far as I have been able to compare them with the originals. This is not a matter of opinion but of ocular demonstration. I have published a plate in the *Illustrirte Wochenschrift für Entomologie*, to which I invite the attention of British entomologists, and upon which I reproduce, by photographic process, Mr Meyrick's figure of the neuration of *Venilia macularia* as published in the *Transactions of the Entomological Society*. Side by side I give the actual neuration of the species, and it is sufficient to say of the two figures that any conclusions or any systems based upon their respective features must run diametrically opposite in all important particulars. Nor is this figure of Mr Meyrick's an exception or an especially unfavourable specimen. The figures in the 'Handbook,' of the diurnals especially, which I have compared, are caricatures in greatest part. The result of recent investigation, as a whole, far from lending itself to any such phylogenetic speculations as have been published by Mr Meyrick and are laid down in paragraph 10 of the Prospectus, runs often counter to any such assumed relationships between the groups. One of the most notable efforts of the present time is Dr Dyar's use of the position of the larval tubercles as a guide in defining taxonomically the larger Linnean groups. In brief, Dr Dyar shows us that the Sphingides, Saturniades and Bombycides (including Noctuidae and Geometridae) are on larval characters separate and homogeneous groups, and that only certain families, such as the Sesiadae, Anthroceridae, Cossidae, Psychidae, etc., are to be removed to the Tineides, their affinity with this latter group having been previously noticed by different observers from other characters than the position of the tubercles. Further, it becomes probable, through the researches of Dr Chapman, that the phylogeny of the larger groups above cited, and including the diurnals, leads independently to ancient forms, of which the Tineides are the modern, less changed survival. It seems thus that the day butterflies, the Hawk Moths and the Emperor Moths may have their separate origin in the Tineid group, while the taxonomic character revealed by Dr Dyar confirms their respective homogeneity. The supposed phylogenetic lines by which Mr Meyrick traces the descent, as given in paragraph 10, are drawn without reference to the characters brought forward by Dr Dyar. The most serious objection to their adoption lies, however, in their being insufficiently or not motived by Mr Meyrick. Indeed, it is easy to show that, in the diurnals of Mr Meyrick's 'Handbook,' the charac-

ters of neuration are not understood by the writer, in that the generalised form is made on occasion to proceed from the specialised, instead of the reverse.

But it cannot be my intention here, nor will it serve my purpose, to enter into a detailed criticism of Mr Meyrick's writings. It is sufficient to show that Mr Meyrick's arrangements are unsafe and should clearly not be trusted to in a work of the general character proposed by the British Museum. This work should recognise the main groups in the sequence adopted, not by Mr Meyrick, but by Linné and Fabricius, while any changes in the composition of these groups should be limited to such for which a large amount of evidence has been recorded. It is, philosophically speaking, certain that a linear arrangement is in itself unnatural, but the practical difficulty of reflecting the probable phylogeny in our books is not obviated by adopting Mr Meyrick's 'lines' in the present case. To trust to these will, it appears to me, endanger the undertaking and set the whole work adrift at the outset, while their employment will prevent many, through lack of confidence, from embarking and sharing in the labours of the voyage.

A. Radcliffe Grote.

Roemer Museum, Hildesheim.

A QUILTED SQUID. *Onychoteuthis ingens*, E. A. Smith.

Reduced to about a quarter, linear. On the right side the skin is partially removed so that the papillae are bare. Only the head of this species was previously known.

The block has been kindly lent by Dr Einar Lönnberg.